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The Examination of Selected Physiological and Psychological Parameters in the Preparation of Elite Slalom Canoeists for an Olympic Competition

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ABSTRACT

The study examined the physiological and psychological changes taking place over a whole year identifying whether any relationship existed between these parameters and international performance. Quantitative and qualitative methods were utilised. Six subjects undertook 2-minute canoe ergometer sprint and Wingate laboratory tests. Questionnaires completed included a CSAI-2 (Martens 1990) before every international event including an Olympic Games and the SPSQ (Nelson & Hardy 1990). Qualitative data contained personal construct profiles, clinical interviews and case histories of the psychological interventions. Analyses of the data revealed significant improvements over a year in peak power, minimum power, total work and distance as measured by the Wingate test. There was deterioration in peak $\dot{V}O_2$ and recovery $\dot{V}O_2$ (MAOD)but these were not significant. No significant relationship was found between the laboratory physiological tests, volume of training and international performance. Significant relationships emerged between volume of training and some laboratory tests, particularly strength training.

There were no statistically significant predictions, for the group as a whole, shown using the CSAI-2 sub-components of cognitive anxiety and confidence with international performance and of any interactive effects of these components. There was some weak evidence of prediction between somatic anxiety and performance. Statistical evidence did not support Hanin's (1980) Zone of Optimal Functioning in relation to the subjects' measures on the sub-components of the CSAI-2. Performance was not improved when subjects were in the zone; slalomists performed better when outside the zone. The CSAI-2 indicated that these slalomists showed exceptionally high levels of confidence prior to competition. However, the case studies and clinical interviews indicated that anxiety was present. Analysis revealed the most important factors identified by the subjects for success at elite level were motivation, confidence, relaxation and determination. The range of problems experienced by subjects reinforces the necessity for individual interventions. Monitored, psychological interventions, had varying degrees of success.

Summary

The summary and main findings that emerge from this thesis are summarised below:

1. The purpose of the physiological aspects of this study, using elite level subjects over one competitive season including an Olympic Games, was: firstly to record any physiological changes; secondly to identify whether there were any relationships between the physiological components being measured; thirdly to establish whether any of the laboratory tests predicted competition performance at three international events during one season; fourthly to record training time in minutes spent on selected physiological parameters; fifthly to establish whether any of the laboratory tests related to the time spent on training the physiological components; sixthly to identify whether any relationships existed between the amount of time spent training the physiological components and performance at international events.

2. The purpose of the psychological aspects of this study was using elite level subjects over two competitive seasons at international events including an Olympic Games to: firstly, assess their pre -competitive state anxiety; secondly, to measure the effect of this anxiety on the performance within a multi-dimensional framework; thirdly to explore the validity of Hanin's (1980) Zones of Optimal Functioning hypothesis; fourthly to assess the individual's behaviour in relation to competition; fifthly apply appropriate interventions; sixthly evaluate the effectiveness the interventions, and thereby acquire a greater understanding of the individual, in ecologically valid settings, in preparing for major competitions including an Olympic Games.

3. It is suggested that this is the first time that a coach has conducted research that has adopted a dual physiological and psychological approach over one whole year, with elite slalom canoeists, and where the researcher has also been integrated as part of the dynamics of the group.

4. In addition to physiological and psychological testing, case study and the effectiveness of the interventions has formed a part of this study. All the research has as its main focus the relationship of physiology and psychology to international performance.

5. The subjects for this study were six world class canoeists. Their physical characteristics were as follows: mean age of 25.83 years in 1992 (s.d. $\pm$ 3.05); body mass (kgs) 68.96 (s.d. $\pm$ 3.9); height (cms) 173 (s.d. $\pm$ 5.5); and sum of skinfolds 22.5 (s.d. $\pm$ 1.6). All had represented Great Britain at international events. The group contained the World champion, the World cup series champion, the winner of the European events and two silver medallists.

6. Laboratory testing of physiological parameters did reveal that over the four phases of the competitive year the subjects showed significant improvement in peak power, minimum power, total work, and distance as measured by the Wingate and 2 Minute test. However, there was a slight deterioration in $\dot{V}O_2$, and $\dot{V}O_2Rec8$, but these were not statistically significant

7. There were significant negative correlations between the Wingate Anaerobic test and the 2 Minute test conducted on the canoe ergometer with reference to minimum power and peak $\dot{V}O_2$, and minimum power and distance travelled.

8. No significant relationship was found between selected laboratory physiological tests and international performance over a whole competition season including an Olympic games.

9. The research attempted to reduce the influence of skill by using intra-individualisation comparisons, and conducting the physiological tests in a controlled laboratory environment. Despite this a question still remains as to the relevance of the laboratory tests in monitoring physiological parameters in relation to predicting performance outcomes.

10. There were large individual variations in the volume of training undertaken by individual athletes over the four phases of the competitive year.

11. The volume of training that was recorded, indicated that athletic training had the least variance throughout the competitive year.

12. Recorded training involving paddling clearly showed the greatest amount of time was spent developing skill on whitewater gates, compared to other modes of water training.

13. There were significant relationships between the time spent on training and a number of measures ascertained using the Wingate and 2 minute tests. These include in Phase 1, Peak $\dot{V}O_2$; distance; in Phase 2, distance; minimum power; $\dot{V}O_2$Rec8; in Phase 3, minimum power; $\dot{V}O_2$Rec8 and total work.

14. No significant relationships were found between training and laboratory measures in the final phase (4) of the competition year.

15. The research revealed that of all the volume of time spent on training parameters, strength had the greatest number of correlations with the laboratory tests.

16. International performance was not significantly correlated with the volume of training associated with whitewater skill development or physiological parameters.

17. There were no significant correlations between the volume of time spent training and specific physiological components associated with either the phosphate system or the aerobic system.

18. It is suggested that as strength training correlated with more of the laboratory tests than any of other physiological training areas, then it may have a significant role in contributing to competitive performance. This warrants further research.

19. The research, surprisingly, did not show any significant relationship between the volume of skill training (whitewater gates) and performance.

20. There were no statistically significant predictions shown using Martens (1990) CSAI-2 sub-components of cognitive anxiety, and confidence with performance. This was the case for the group as a whole and in only one case was this shown to be different for one individual.

21. There was some weak evidence of prediction shown using Martens (1990) CSAI-2 sub-components of somatic anxiety with performance for the group as a whole with the level of significance just reaching the 10% level.

22. There was no statistical evidence to support Hanin's (1980) Zone of Optimal Functioning, in relation to the subjects' measures on the sub-components of the CSAI 2. Performance was not improved when the subjects were perceived to be 'In the Zone'. In fact it appeared that the slalomists performed better when outside 'The Zone'.

23. The research did not support the psychological interaction model of cognitive and somatic anxiety in relation to performance in a multi-dimensional framework.

24. Competitors at elite level of canoe slalom do not, as measured by Martens CSAI-2, show anxiety immediately within 15 minutes of starting an international event including an Olympic Games.

25. The variety of psychological problems that were identified in this study would indicate that there is a need to use a variety of interventions. The use of only one type of intervention applied to the whole elite squad is likely to be inappropriate given the findings of this study.

26. There are indications that at elite level, the CSAI-2 may not be a sensitive enough instrument to measure small changes that would form part of a deterministic model related to performance.

27. The CSAI-2 scores indicated that these elite performers were not cognitively or somatically anxious and showed high levels of confidence. However the case studies did reveal that these subjects were often experiencing anxiety in various forms before competition.

28. A range of psychological problems was revealed using clinical interviews, self-construct techniques and the SPSQ questionnaire. A number of these problems were in contrast to the issues that were highlighted from the results of the CSAI-2.

29. These elite subjects identified the most important factors for success as motivation, confidence, concentration, relaxation and determination.

30. Elite subjects regarded visualisation, and being level headed and patient as of some importance but not the most important factors for psychological preparation for success.

31. Undeveloped areas of psychological preparation using the SPSQ were imaginal skills and mental preparation in general. These were also common to the subjects' self-constructs.

32. All subjects demonstrated an extremely high level of motivation.

33. Self confidence was seen as an issue of critical importance and all subjects had a lack of this at some stage as revealed through the case studies. The causes and manifestation of this varied among individuals. This finding is in contrast to the results of the confidence scores as measured by the CSAI-2.

34. Underpinning factors, concerned with problems regarding confidence, included subjects' perception of control over external factors, and perceived ability to match the challenges ahead.

35. Despite having problems with confidence, these elite performers did have great success at the highest levels of competition.

36. Concentration was not only necessary in competition but also was regarded by subjects as important in training to make improvements.

37. Significant others do play a major part in some of these elite performers' lives. This is the case within the squad in which they operate and in their personal relationships outside the squad.

38. It is not clear from these case studies what the internal determinants of concentration are, how these can be improved, and why they deteriorate.

39. There is some limited evidence that process goals may interfere with the automatic nature of the skills that a number of these elite athletes have mastered.

40. Some of the interventions that were adopted may either have made the problem worse or had no effect. There is some suggestion that because of the complexity of the psychological problems, which were not only concerned with competitive performance, that they may really be the remit of clinical psychologist rather than sports psychologists.

41. Slalom canoeing at international level is an individual sport; however there was clear evidence that the dynamics within the group had an effect on individuals and the way in which they prepared for competition.

42. There were clear advantages in the coach being able to perform roles within psychology and physiology, particularly in relation to prescribing and monitoring conditioning.

43. The author, who was also coach, was affected by the group dynamics of the squad, where the boundaries between coach and athlete may be difficult, and possibly undesirable, to establish and maintain.

Table of Contents

List of Tables in Text

List of Figures in Text

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CHAPTER 1

Introduction

1.1 Context of the research

The sport of canoe slalom takes place in either a kayak -a single seater boat in which the competitor sits down and has a double bladed paddle - or in a canoe in which the competitor kneels down and has a single bladed paddle. Canoes can also be for two men. Both men and women compete, but women are only allowed to compete in kayaks.

Slalom canoeing at elite level involves paddling the boat down moving whitewater through a series of 25 gates in a set order. Gates have to be negotiated in either a forward direction with the current or upstream against the current. The competitor is timed and time penalties are added for either touching or completely missing a gate.

The competitor is allowed to inspect the course beforehand but is only allowed one official practice run. Two competition runs are then completed. The better run is the one that is counted as the final result. Modern slalom competition tends to be held on dam controlled rivers or on artificial courses where the flow of the river can be controlled, making it almost the same for every competitor.

The sport is world wide but there are fewer nations competing from the South American and African continents. The World championships have been held each alternate year since 1949. Slalom was introduced for the first time to the Olympics in 1972, then again in 1992 and 1996, and will feature in the year 2000 Olympics in Australia.

In general there have been two periods in which various nations have dominated whitewater slalom. In early World championships Austria dominated the kayak event and France the canoe event. By 1957, however, East Germany (DDR) was the dominant country in most events. There have been times when they did not send a team (1969 and 1979), but every time they sent a team they won overall. Clearly, at that time their system of producing elite performers was partly the result of their highly organised, government supported training programme. After 1972 slalom was withdrawn from the Olympics because of the cost of building artificial courses. East Germany then took less interest in competing at international level and their performances since that time have diminished to virtually nothing.

Great Britain had early success, winning a gold medal in 1959, then again in 1977. Since that time Britain has been become a dominant force in both mens and womens kayaks. However, success is more widespread among countries now. Athletes in the most successful countries train full time and have full time coaches along with a full time support team of sports scientists. Britain has this only in part, and does not provide state money for athletes to train. Access to suitable training facilities is a critical factor for developing techniques at an elite level. In order to train the whole year around, finance to travel and spend time in countries with appropriate whitewater and a suitable climate is required.

In Great Britain it is not easy to develop skill on whitewater and to then transfer this to slalom competition. Legal access to rivers is restricted. Permanent slalom sites are few and far between. The most suitable levels of water in rivers tend to be in the winter, when it is cold to train, requiring special clothing. Safety is a paramount factor and training alone on fast moving water on rapids can be dangerous. During winter training floodlights for evening sessions are required which are rare on natural rivers. A car is required to transport the canoe to and from sites. On reaching a stretch of river which is suitable for training then gates need to be hung before starting. To provide a variety of problems which are necessary to develop skill means constantly changing gate courses, which is not an easy matter.

The development of artificial slalom sites has alleviated all the problems stated above. However in this country only two fully functional sites have been developed. Of these only one functions all year and can also suffer from drought and flood. So although the facility is exceptionally good for training there is still a need to work on other rivers to get the full range of skills that are required at international level.

The last eight years have seen some major changes in the rules in slalom: gates that had to be negotiated with the boat travelling in a reverse direction have been eliminated; the penalty for hitting gates has been reduced and the length of courses has been brought down from over three minutes to approximately 120 seconds.

Boat design, paddle design and accompanying equipment have undergone some interesting changes. Boats are required to have minimum dimensions and weight, otherwise the design is left to the individual designers and manufacturers. The result is that some boats turn faster or travel in a straighter line or are better in larger volumes of rough water. Having a boat to suit the particular site where the major championship takes place became the norm. It means that manufacturers have to be well in advance with their designs to meet schedules for the elite. Paddlers also have to get used to the new design and make adjustments throughout the off season. Paddles have a number of variations, the most radical of which has been the crank shaft. This enables the performer to present the blade to the water in a more efficient manner. Availability of this equipment is restricted to those who produce the designs, and is seen as part of the competition in the sport.

The author of this thesis, while working as both scientist and coach to the British men's kayak squad, has felt that there are particular reasons for their success at this elite level. This is particularly pertinent given the less favourable circumstances, compared to other nations, in which Britain has produced winners. In order to maintain such a high standard it would be advantageous if the factors that are critical for success could be identified. Most importantly it is crucial that these critical factors can be incorporated into practical coaching.

1.2 The impetus for the research

The impetus for this study of selected physiological and psychological factors in the preparation of Olympic canoeists was initiated by personal experience. As Great Britain coach for 16 years the author has had ample opportunity to discuss matters of preparation with fellow National coaches, psychologists and physiologists. However, after much discussion with these colleagues, it became apparent that much dissension existed concerning the different contributions of physiological and psychological factors to performance at an elite level.

The determinants of performance in slalom canoeing are complex. It has already been pointed out how difficult it can be to train to get the skills required on advanced whitewater. The nature of the sport, in which a new course is set for every event, also makes it tricky to ascertain exactly what ingredients are required in terms of fitness, power, skill on gates, manoeuvres on moving water, and the mental preparation concerned with decisions, memory, bravery and having to deal with constantly changing patterns of water. It could be argued that if one had all of these skills in abundance then one could deal with anything that was presented. This is not in dispute. The problem is that there is not enough time, and the body cannot necessarily take a heavy load of training day after day without the necessary rest, and in any case strength takes quite a few years to develop. There may also be a better "pay-off" in spending less time on the physiological aspects and more on the development of skill. The real issue is that it is not known exactly where the thresholds are situated after which there are diminishing returns in any of the determinants of performance.

The nature of canoe slalom means the performer is required to have specific canoeing skills that are related to slalom. In particular they need the ability to judge and utilise the effects of whitewater on the speed, balance and direction of their boat. This ability is then needed to establish, from an inspection on the bankside, the most appropriate way to negotiate a sequence of gates in the shortest possible time. Underpinning this ability are several physiological and psychological parameters, which ultimately appear to contribute to the overall performance of the athlete.

Physical training is necessary to bring about physiological and metabolic adaptations as a result of performing repeated bouts of exercise over several days, weeks and months. These adaptations are designed to improve performance in specific tasks. The nature and magnitude of the adaptive response is dependent on the intensity and duration of the exercise, the mode of training and the frequency of the repetition of the activity.

It is generally agreed among coaches that the main purposes of the physiological training are to establish: an endurance base to improve fatigue resistance; anaerobic training to bring about specific changes in the immediate and short term energy delivery systems; resistance training to increase the total muscle mass and the maximum power that can be thus generated.

Observation by the author would indicate, that for competitors to be successful at elite level, requires psychological skills that can cope with adversity; that can maintain concentration and control particularly at major international events; deal with stress and anxiety; produce self-confidence as an individual and in relating to significant others within a team situation.

Published studies of elite (World Class) performers in sport are extremely limited (see the review of literature for each section) and the author felt that there was a limited amount of common knowledge of how canoe slalomists achieved high levels of attainment. However, this limit of knowledge may have existed only among the coaches, the athletes might be clear about how they as individuals achieved the ultimate performance (the sample contained the World Champion and World Cup winner). It was therefore felt that closer examination of this knowledge might well reveal that they follow clearly defined strategies learnt both by trial and error and by observing fellow competitors.

By recording, examining and monitoring the preparation strategies of these elite performers, as individuals and as a group, over a prolonged period it might be possible to identify the critical components that lead to improved performance. This possibility provided the impetus to investigate selected factors of preparation. At this stage there appeared to be three options available in terms of the type of investigation that could be undertaken:

(i). a physiological and psychological study of elite performers involving an experimental design, control groups, and accounting for the numerous variables.

(ii). a comparison of the differences physiologically and psychologically between elite and non-elite performers.

(iii). a non-experimental physiological and psychological examination of the preparation for an Olympic competition by elite performers within an ecologically valid environment.

Each of the above areas merited research. However given the specific task of improving the preparation of future Olympians, it was considered that the third area, by recording, monitoring, and analysis of training, and further, by testing the efficacy of psychological interventions, would make the greatest contribution to current knowledge.

The study also had to be undertaken within certain constraints that are particular to elite performers. Each performer was attempting to produce the best performance of which he was capable in international championships and ultimately the Olympic Games. On this basis, it would be unethical and impractical to expect such competitors to be part of experimental research in which certain controls or interventions would be imposed. Likewise, any physiological training or testing would have to take account of the individual's personal training schedules and preparation plans. This would then restrict the research design outlined in (i) above.

The second research possibility would have limited application in taking us forward in both our theoretical knowledge and in trying to improve performance with the elite group. The fact that the elite may have specific skills or psychological attributes would act as a classification of differences, but would not necessarily inform us of how these aspects are developed, nor would it be possible to apply the research methodology to the international situation, as the non elite would not qualify for such events.

Bearing all these factors in mind, the author, who was both coach and responsible for the application of science to the training and mental preparation of these Olympic slalomists, had a unique opportunity to conduct this study.

1.3 The scope of the research

The scope of the research is simply stated: to consider selected physiological and psychological factors in the preparation, over a period of approximately two years, of elite slalom canoeists for an Olympic competition; and to evaluate the importance of these factors in contributing to improved performance.

Such a study is clearly limited in scope; the sample of elite, by definition, is small. The study also precludes the consideration of some possible factors that may contribute towards improved performance.

Any attempt to reduce the variables that constitute performance to, for example, a number of physiological tests in the laboratory does have serious limitations. Slalom does require among other things quick reactions, hand eye co-ordination, judgement, balance and the ability to ascertain the quickest way in which to complete a sequence of gates. Probably the only relevant way to test this is in a field setting.

It should therefore be clearly understood at the outset that acceptance of limitations implies neither a limited view of the preparation of elite performers nor neglect of the possible importance of other factors.

Using a dual approach and at times a variety of research methods which had limitations is not an exact science but rather an attempt to make sense of the factors that both make up and contribute to performance in an ecologically valid environment. It also highlights the problems faced by the coach and scientist when trying to deal with the problems of elite performers. There would be a possibility that the differences in performance between individuals may involve variables that are greater than the ones being measured, but these may not yet have been identified. Furthermore useful information cannot always be checked and replicated as the information from elite performers can be regarded as unique, perhaps a passing moment in an Olympic competition. Even the same competitor may not be able to replicate the same mind set or bring the same experience to each occasion. Human beings are complex and elite athletes appear to be no less so. But what may make the issues of measuring and evaluating the components pertaining to performance valid is the possibility that these successful athletes are not affected at the last minute by any distractions or emotions because their preparation has been so thorough.

These factors dictate that it is important that a variety of approaches are used in the field over a prolonged period of time by the researcher being in situ. Case study is particularly pertinent as it reveals problems which can be acted upon. Additionally a multifaceted method is likely to reveal some underlying states. The holistic approach may also show some interaction within the elite athlete which would not be revealed by having a narrow controlled approach.

The unique position of the author cannot be over-emphasised especially as he was travelling, coaching, managing and gathering research data in a full time capacity. Gathered data, together with circumstances in which the elite performers and the coach found themselves, had to be acted upon in the most productive way. The elite had to produce results at that moment. Sport is a prisoner of time. It can be stated with confidence that no other person would have been able to obtain this information at the time with such a talented group of Olympians. Twelve years of coaching and researching this group has provided a thorough insight into preparation and competition. The information gathered is not necessarily weakened due to its field setting limitations. Instead the long period of involvement allows many mini pictures to appear.

Slalom canoeing has been under-researched; the lack of literature reinforces this view. It is necessary when observing top performers to bear in mind that one is gaining an insight into current practice, but not necessarily the best practice. At the same time it is appreciated that it is not easy to research the area. Physiological field data collection is fraught with problems. Slalom courses are often relatively remote, have no power sources, access to the riverside can be problematic, cover from the elements are usually non -existent. Portable waterproof battery operated equipment is only just becoming available.

Measuring performance also proves to be problematic. Courses vary in length, intensity, and difficulty. Certain international events may also have varying standards of competitors. All of these factors mean that the data collection has to be conducted within many constraints, which may partly account for the comparative lack of research reported in the sport of slalom canoeing.

1.4 Purpose of the research

The purpose of this research was to gain a better understanding in world class slalom canoeing of the underlying factors that determine performance at elite level.

The research reported in this thesis has been written as a collection of papers with an introduction and an overall conclusion. These form the six separate chapters.

Chapter one introduces the context, impetus, scope and purpose of the research.

In chapter two physiological data has been collated and analysed over a period of time in order to see whether laboratory tests reflect performance indices in elite slalom canoeists.

Chapter three examines the relationship between physiological training, laboratory tests, and performance in elite slalom canoeists.

In chapter four a psychological analysis of the generalizability of anxiety/performance relationships to elite slalom canoeists is reported.

Chapter five consists of individual case studies of the psychological preparation for international performance including the effectiveness of the interventions adopted.

Chapter six brings together the principal findings to form the conclusion.

Where appropriate the research is a mixture of individual and group analyses and much of the reported work has taken place within the constraints of using elite performers in a field setting over a minimum period of twelve months. It represents a dual research approach incorporating physiology and psychology, together with the application of sports science by their coach. It also gives a close up perspective of the actual preparation of elite performers preparing for an Olympic Games, something not previously reported in the literature.

CHAPTER 2

Do clinical tests reflect international performance indices in elite slalom canoeists?

2.1 Introduction

International competitive slalom canoeing[1] involves paddling a course on white water through a specific series of suspended gates. The time taken to complete the course varies for each paddler but is approximately 2 minutes depending on course length and technical difficulty. The paddler is required to constantly accelerate and decelerate the boat both with and against the power of the water to negotiate the gates.

The event may be classified as 'multiple sprint' in that it is characterised as having periods of intense effort interspersed with periods of less intensity (Williams, 1987). In such circumstances the force generated during repeated muscular contractions approaches maximum. These contractions are primarily dependent upon anaerobic processes for energy release (di Prampero, 1971). Anaerobic capacity has been defined as the maximum amount of adenosine triphosphate (ATP) resynthesised via anaerobic mechanisms during a specific short-duration maximal exercise (Green and Dawson, 1993).

Medbo and Izumi (1989) have highlighted the importance of the anaerobic component in shortlasting exercise but have reported that it is difficult to quantify. However given that the amount of creatine phosphate and lactate that can accumulate in blood and muscle is limited (Karlson and Saltin, 1970; Hermansen and Vaage, 1977; Hultman and Sjoholm, 1983) then it would seem that there is a maximum amount of anaerobic energy that can be released during exercise. This has been termed the anaerobic capacity (Medbo and Izumi, 1989).

Anaerobic training forms an important part of the elite slalom paddler's physiological preparation for competition. Measurement and monitoring of the development of the anaerobic component is therefore considered to be an important indicator of physiological status in preparation for competitions. However, the literature relating to measurement of

[1] Generic term which includes the use of kayaks as well as canoes

the anaerobic components is far from clear. Controversy over the terms and the protocols for measuring those components is very apparent. For example perusal of the research associated with the Wingate Anaerobic Test (WAnT) indicates that it measures a combination of different components of anaerobic metabolism. It is regarded as a test of anaerobic power not as a test of anaerobic capacity (Armstrong et al. 1983; Bar-Or, 1987; Patton and Duggan, 1987; Medbo et al. 1988).

The above is based on the fact that although the test is performed at maximal intensity throughout there is a contribution from aerobic sources ranging from 13% to 29% (Inbar et al. 1976; Bar-or, 1987). The WAnT is regarded as a test of anaerobic components and is seen by Green (1995) as an anaerobic work capacity test because it gives an index of work output and is underpinned by a relatively high anaerobic adenosine triphosphate yield. Even though the WAnT lasts 30 seconds it is not considered to be an anaerobic capacity test because it does not consider the aerobic component (Medbo and Izumi 1989; Winter, 1991). It is also Winter's (1991) contention that the WAnT is simply a test of anaerobic performance. Furthermore the WAnT has been extensively investigated (Vandewalle et al. 1987) and despite various confounding problems it has been shown to be a robust test (Jakeman et al. 1994).

In addition several investigators have suggested that the maximum accumulated oxygen debt is a measure of anaerobic capacity (Hermansen and Medbo, 1984; Medbo et al. 1988; Saltin, 1986; Scott et al. 1991). However, Green and Dawson (1993) suggest caution, as the validity of these measures in athletic populations has not been clearly established.

There have been few investigations that have measured the various aspects of anaerobic power and capacity of elite athletic groups over a period of time, one example being that of Patton and Duggan (1987). Additionally there is comparatively little exercise physiology research reported during the last five years concerned with adult elite international subjects (Chin et al.1992; Peltonen and Rusko, 1993; Smith et al.1992; Dey et al.1993; Bangsbo et al.1993; Koutedakis et al.1993). Of these only Smith et al. (1992) conducted work that was related to competition results over a period of time.

Opportunities to study high performance elite groups are rare and they do form a unique population in which to study the physiological responses to exercise (Patton and Duggan, 1987). However it has been suggested by Green and Dawson (1993) that measurement of these physiological parameters should be tested under conditions that actually simulate the competition event (i.e. intensity, pacing and duration).

The purpose of this study, using elite level subjects over one competitive season including an Olympic games, was threefold: firstly to record any physiological changes; secondly to identify whether there were any relationships between the physiological components being measured; thirdly to establish whether any of the laboratory tests predicted competition performance at three international events during one season.

2.2 Methodology

2.2.1 Subjects

Six world class male slalom canoeists gave their informed consent, and volunteered to take part in a monitoring process in preparation for the Olympic Games in 1992. Their physical characteristics were as follows: mean age of 25.83 years (s.d. $\pm$ 3.05); body mass (kgs) 68.96 (s.d. $\pm$ 3.9); height (cms) 173 (s.d. $\pm$ 5.5); and sum of skinfolds [bicep, tricep, subscapular, suprailliac, Durnin and Wormsley, 1974] 22.5 (s.d. $\pm$ 1.6). All had represented Great Britain at international events. The group contained the World champion, the World cup series champion, the winner of the European events and two silver medallists.

All volunteered on the understanding that they did not have to experiment with their training and that testing would take place when they thought appropriate. They were familiar with testing procedures having been involved in such processes for the previous two years at the British Olympic Medical Centre. The author had coached each of them for periods ranging from six to twelve years.

2.2.2 Design

A non-experimental investigation was used in which two laboratory tests (WAnT and 2 Minute Canoe Sprint Test) were undertaken 8 times to monitor changes with reference to the four preparation and competition phases adopted by the Great Britain Canoe Slalom Team (Mantle, 1990) which were:

Main Preparatory (Phase 1 Nov/Dec)

Preparation (Phase 2 Jan/Feb/March)

Specific Preparation and Competition (Phase 3 April/May)

Specific Competition (Phase 4 June/July)

The two physiological tests were compared to explore the possibilities of significant relationships between them and then related to three international events during one season to see if the tests reflected performance indices.

2.3 Method

2.3.1 Measurement of Performance

Measurement of performance in sport can exhibit certain difficulties in research, particularly in those sports where it is impossible to compare an individual's performance directly against established records, standard times, or personal bests. Slalom canoeing falls into this category as each competition takes place over a unique gate sequence and the nature and flow of the water varies from event to event.

All the competitions in this study were classified as International 'A' events (i.e. highest grade). Each competitor has two competition runs and the best, inclusive of time penalties for hitting or missing gates, is the one that is counted. Penalties at this level of performance tend to be caused by technical errors rather than physiological inadequacies. It was decided therefore to use the best time taken from run one or run two as a measure of performance as this would eliminate any confounding variables such as technical errors. Not all subjects competed in every event due to variations in individual programmes and variations in selection or non-selection for the Great Britain Team. Data were collected from a minimum of 5 events for each subject and, in the case of two subjects, 14 events. Official results were obtained from each event and were used in the calculation of performance measures.

In order to allow for the variation in the nature and length of the different courses, and the different abilities of the subjects, best raw times were transformed to standardised scores. In order to calculate this standardisation the performance times were first adjusted relative to the performance time of the top twenty competitors. The mean and the standard deviation of the top twenty were calculated for each event. The mean was then subtracted from the performance time of each individual and the result then divided by the standard deviation, (Performance time - mean score)/s.d. (Sonstroem and Bernardo, 1982).

A similar calculation was then used to allow for the different individual abilities using the same method with the data that had already been standardised to allow for the different race lengths (the mean and standard deviation being over the events in 1991-1992). This allowed for comparisons of performance for an individual over the race season and can be seen as a performance comparative measure as opposed to a performance outcome measure (Weinberg, 1990).

The advantage of these standardisation procedures is that it allows comparisons of an individual's performance relative to the top twenty performers over a number of events. In effect it is allocating a unit of difficulty consistently across courses and alleviates the necessity of calibrating the true performance time of a particular course. The s.d. does vary according to the difficulty of the course. The more difficult the course the greater the s.d. and vice versa. However, this form of standardisation does have limitations. It relies on the top twenty competitors producing consistently good performances over a period of time. Despite these limitations it probably represents the most accurate method of inter-individual standardisation in a competition where the performance time varies from race to race.

2.3.2 Measurement of Anaerobic Power

Anaerobic Performance was determined for the upper body using the Wingate Anaerobic Test (WAnT) (Bar-Or, 1981), utilising a Monark 864 cycle mounted on a platform and adapted to allow single arm cranking. Restraints were used to fix the lower body, and seating adjusted to allow for individual body size and comfort.

A braking force of 7.5% of the subject's bodyweight (BW) was used. This percentage producing a resistance of 0.075kg BW (Kaezkowski et al. 1982, Rotstein et al. 1982, Patton et al.1985).

Each subject completed a five-minute standardised submaximal warm-up immediately followed by a five second sprint at the test load. A two minute rest was allowed before recommencing the cranking action. Once a frequency of 60 rev.min^{-1}, with a low braking force to facilitate the control of cranking cadence, was attained a countdown from five was given and the full braking force applied. Maximal sprinting from start to finish, with no pacing, for 30 seconds was required (Bar-Or 1987; Green, 1995). The flywheel velocity was measured directly using a photocell which provided a square-wave pulse count for every four degree revolution. These signals were interpreted by a micro-computer interfaced to the device giving the power output for consecutive one-second intervals throughout the test.

Three indices of performance were recorded: peak power in Watts; minimum power in Watts; total work completed in kilojoules.

2.3.3 The Two Minute Sprint Test

This test utilised an air-braked kayak ergometer (Modest, Denmark) that incorporated a magnetic sensor which displayed both the speed of the flywheel and the distance it travelled, together with the time lapsed. The subjects could see this display. The seat height was adjusted for each individual who could use his own paddle shaft. The ergometer was calibrated as per. manufacturer's instructions.

An automated gas analyser (Jaeger Sprint, Hoechberg, Germany) was used to record respiratory parameters every thirty seconds during the testing while subjects inspired room air through a low-resistance two-way Rudolph valve. The gas analysers were calibrated with standard gases (5% O_2 15% CO_2, balanced with N_2). Spot checks were made on the calibration of the pneumotachygraph for volume flows up to 100 litres per minute using a 1-litre syringe.

The test protocol was designed to simulate typical slalom canoe races of the 1990s. Subjects warmed up for as long as they required and then tried to achieve maximum distance in the two minute period of the test (120 seconds being a typical time for international races). Pacing was left to the individual. Peak $\dot{V}O_2$ was recorded in L^{-1}, together with the distance attained. The excess post exercise oxygen consumption (Green and Dawson, 1993) was calculated for a period of 8 minutes post test ($\dot{V}O_2$Rec 8).

2.4 Analysis of the Data

To examine possible relationships between the physiological variables as measured by the 2 MinuteSprint test and the Wingate test, individual scores were standardised by subtracting the individual's mean score and then dividing by the individual's standard deviation. Pearson correlation coefficients were calculated for each pair of test variables for all subjects. Only the 1991 and 1992 laboratory test results were used for this analysis.

In order to examine the possible relationships between physiological variables and performance, and in order to take account of the possible non-linear nature of the data, Spearman rank correlation coefficients were calculated (Sprent, 1989). Using the results for all (five) individuals taken together the data were standardised as already described.

(N.B. one individual was not selected for the International team and therefore no performance data exist for this subject). The laboratory testing dates (first date) were matched as close as possible to the international performance dates (second date) and were as follows:

2nd March 1992 with 22nd February 1992

27th April with 18th April 1992

3rd June 1992 with 6th June 1992

To ascertain any changes in the average level of the physiological parameters over the four training phases, linear regression of the mean physiological measurements across the six subjects, over the four phases of training was conducted.

2.5 Results (raw data Appendix 1)

Inspection of **Table 1** shows only two significant correlations between the Wingate test and the 2 minute canoe test. Minimum power and peak $\dot{V}O_2$ is negatively correlated (-0.35 $p<0.05$) as is minimum power and distance (-0.41 $p<0.05$).

Table 1 Pearson Correlation (all subjects) for the Wingate and the 2 Minute Sprint Canoe Test

Variables	$\dot{V}O_2$	$\dot{V}O_2$Rec8	Distance
peak power	-0.11 p= 0.43 (*n*=40)	-0.27 p=0.21 (*n*=39)	-0.07 p=0.84 (*n*=41)
minimum power	-0.35 p=0.01* (*n*=40)	-0.22 p=0.33 (*n*=39)	-0.41 p=0.03* (*n*=41)
total work	-0.12 p=0.45 (*n*=40)	-0.19 p=0.21 (*n*=39)	-0.12 p=0.82 (*n*=41)

n = number of data points
* denotes correlation significantly different from 0 using a two-tailed test at the 0.05 significance level.

The analysis summarised in **Table 2** shows no significant relationships between standardised laboratory tests and standardised international performance at the 0.05 level.

Table 2 Spearman Rank Correlation (all subjects) for standardised international performance and standardised laboratory Tests.

Standardised Variables	Peak Power	Min. Power	Total work	$\dot{V}O_2$	$\dot{V}O_2$Rec8	Distance
Standardised performance	0.45 p=0.22 (*n*=9)	0.27 p=0.49 (*n*=9)	0.30 p=0.45 (*n*=9)	0.11 p=0.82 (*n*=7)	-0.21 p=0.65 (*n*=7)	0.12 p=0.78 (*n*=9)

n = number of data points

The physiological tests plotted over the four preparation and competition phases in conjunction with linear regression over this time period are given in **Figures 1 to 6** and **Table 3** respectively.

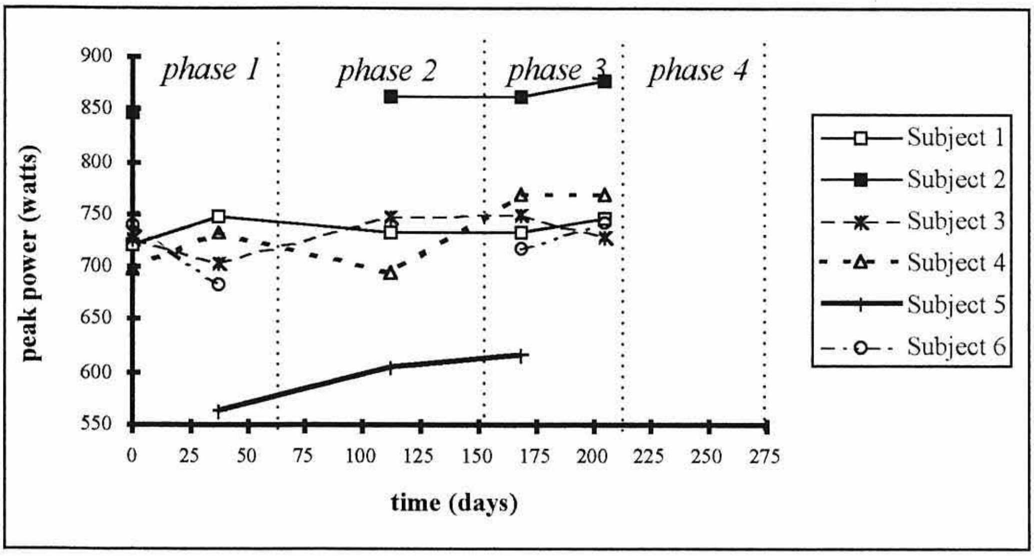

Figure 1.Wingate laboratory test peak power for individuals over the four periodic phases

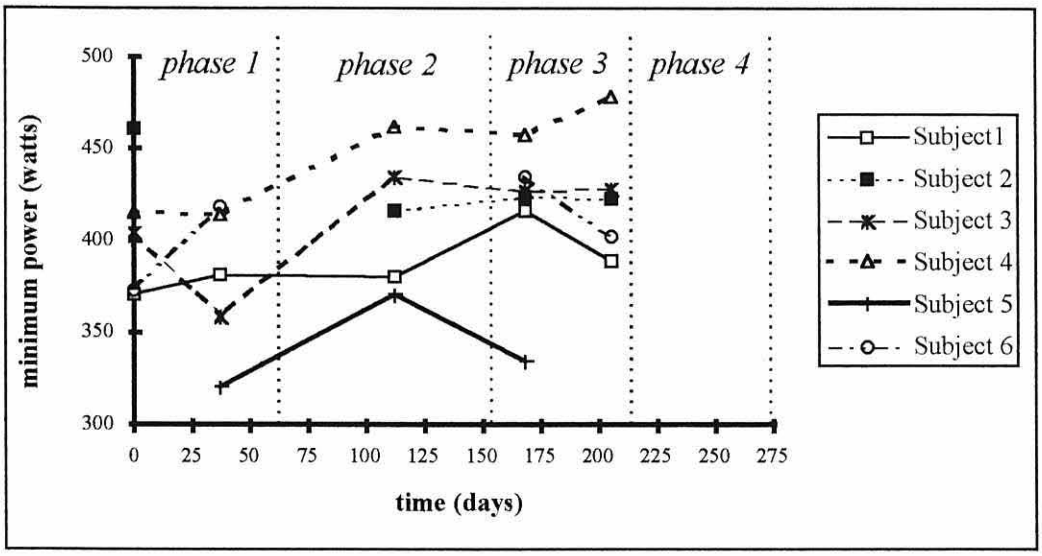

Figure 2. Wingate laboratory test minimum power for individuals over the four periodic phases

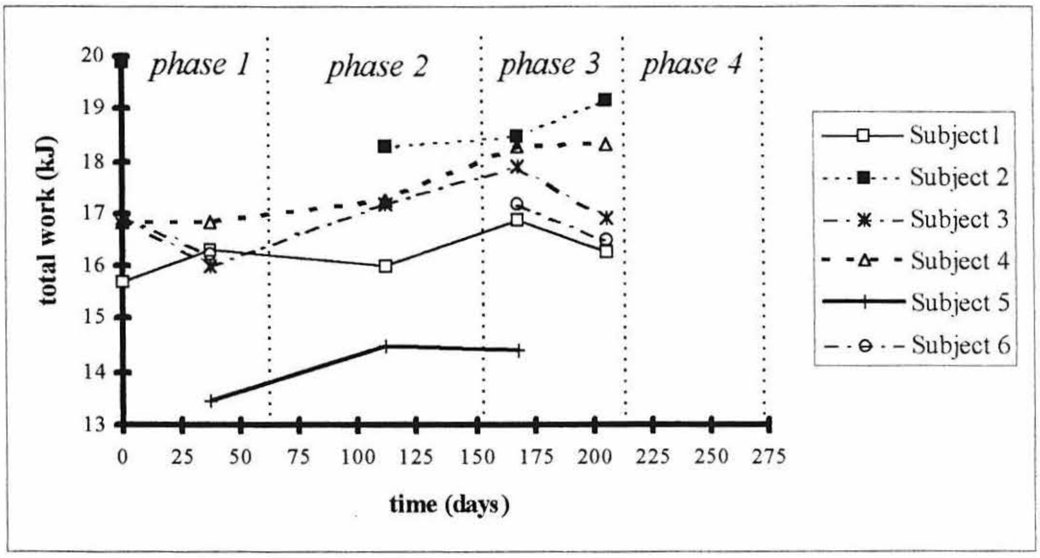

Figure 3. Wingate laboratory total work for individuals over the four periodic phases

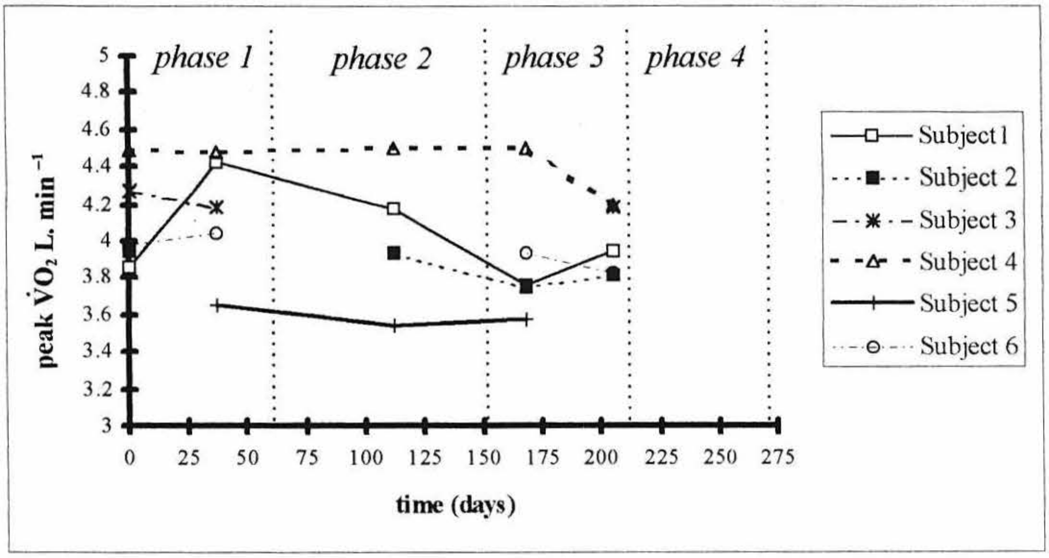

Figure 4. Two minutes laboratory canoe sprint test peak $\dot{V}O_2$ for individuals over the four periodic phases

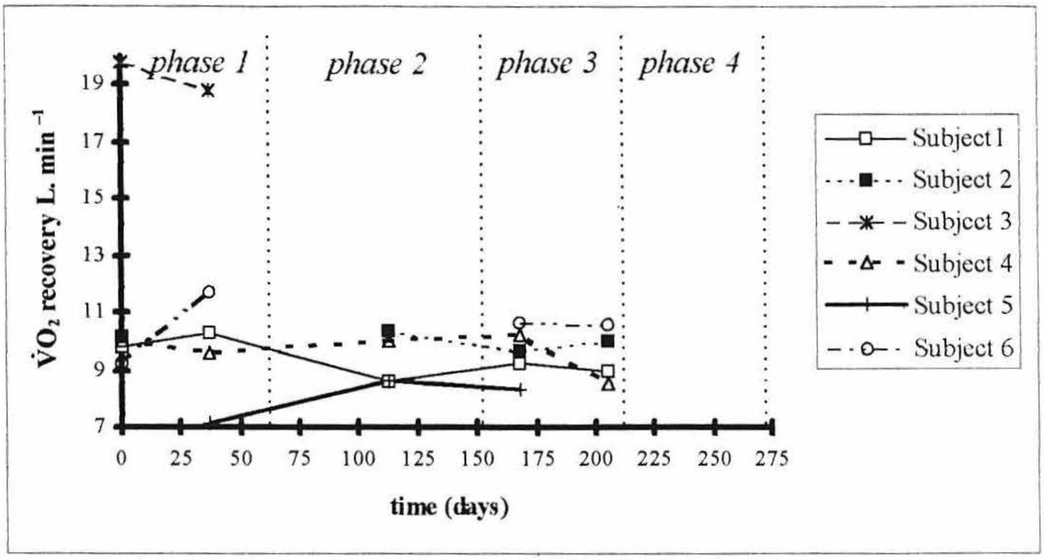

Figure 5. Two minutes laboratory canoe sprint test $\dot{V}O_2$Rec8 recovery for individuals over the four periodic phases

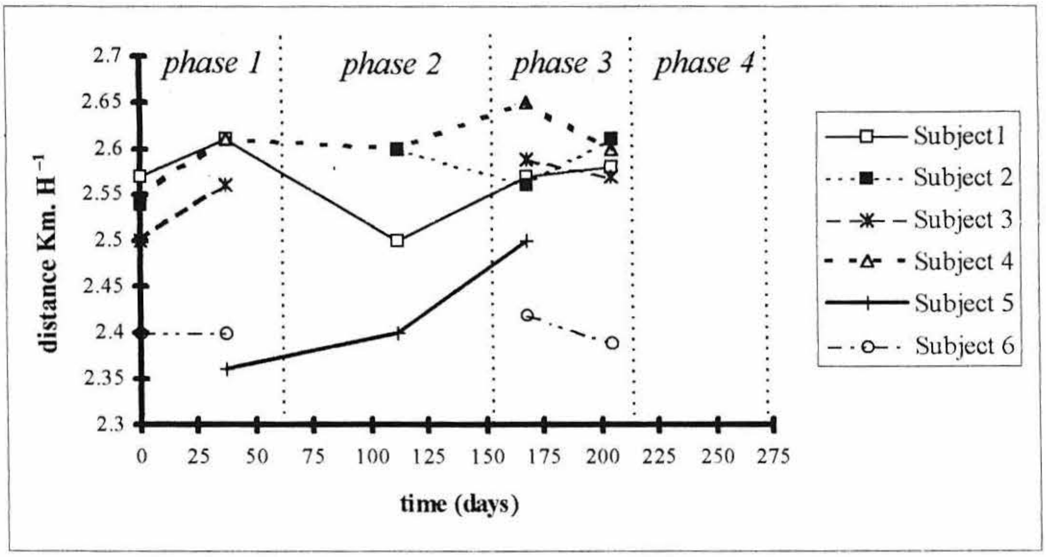

Figure 6. Two minute laboratory canoe sprint test total distance for individuals over the four periodic phases

Table 3 Linear regressions of mean physiological tests against time.

Dependent Variable	Estimated Slope	Standard Error	F - Value	p - Value
peak power	0.4800	0.0644	55.64	0.02*
minimum power	0.2580	0.0640	16.24	0.06*
total work	0.010030	0.000736	185.77	0.01*
peak $\dot{V}O_2$	-0.001189	0.000537	4.90	0.16
$\dot{V}O_2$Rec8	-0.01124	0.00562	4.00	0.18
distance	0.0002697	0.0000378	50.96	0.02*

* = significant at the 0.05 level

The linear regressions over the four phases of training summarised in **Table 3** shows :

improvement in peak power ($F_{1,2}$=55.64 p=0.02), minimum power ($F_{1,2}$=16.24 p=0.06), total work ($F_{1,2}$=185.77 p=0.01), and distance ($F_{1,2}$=50.96 p=0.02). There was a deterioration in peak $\dot{V}O_2$ ($F_{1,2}$=4.90 p=0.16), and $\dot{V}O_2$Rec8 ($F_{1,2}$=4.00 p=0.18) however these were not statistically significant.

Closer inspection of the **Figures 1** to **6** does show some variations with individuals at the various phases of time but the overall analysis would be accurately described as in **Table 3**.

2.6 Discussion

The phases of training are designed so that there is initially a greater emphasis on the aerobic components followed by an emphasis on the anaerobic aspects nearer to competition. Therefore the results would be expected to show an improvement for certain laboratory tests in connection with the development of the anaerobic physiological measurements for peak power and minimum power **(Figures 1 and 2)**. This does not wholly support other research monitoring physiological changes during the 'off' and 'in' season (Andersen and Montgomery, 1988; Koutedakis et al. 1993).

However it would have been expected that the peak $\dot{V}O_2$ and $\dot{V}O_2$Rec8 would have increased during phase 2 but this was not the case (**Figures 4 and 5**). The small down-trend in the aerobic conditioning is shown in the figures leading into phase 4 (specific competition). This finding does concur with studies on the effects of training where there has been demonstration of % improvements in performance being greater than % increase in $\dot{V}O_2$ max (Ekblom, 1969; Daniels et al. 1978, Gollnick, 1989). The same authors have also shown that after initial increases in $\dot{V}O_2$, max continued training resulted in little or no further changes in $\dot{V}O_2$, max but performance continued to improve. (Although note in these studies it was $\dot{V}O_2$ max that was measured not peak $\dot{V}O_2$). If the 2 Minute Sprint test is regarded as a useful laboratory performance measure (and it is by these elite slalom canoeists) then the results shown in **Figure 4** for peak $\dot{V}O_2$ and **Figure 5** for $\dot{V}O_2$Rec 8 all show downward trends compared to the preparation phase 1. **Figure 6** (distance) shows improvement, which is expected. It was also expected that the conditioning phases undertaken prior to the final testing would be sufficient to elicit an improvement in canoeing economy which would have been shown by a decrease in peak $\dot{V}O_2$ and an increase in distance at the final testing stage.

As the WAnT and the 2 Minute Sprint test purport to measure different physiological components it was interesting to see if there was any correlation between any of their sub-components. The results do show a significant negative relationship at the 0.05 level between minimum power /peak $\dot{V}O_2$ and minimum power /distance. Minimum power in the WAnT can vary depending how the subject applies himself to the 30s test. Motivation has been shown to have an affect (Bar-Or, 1987), and so has verbal encouragement on the effect on maximum effort in voluntary muscle action (McNair et al. 1996). However as minimum power is the end point in the decrease from peak power to minimum power it is very dependent on the level of peak power reached, the higher levels tending to produce a lower minimum power. The data from this study have shown the measures on minimum power are negatively correlated with the distance attained in the 2 Minute Sprint test. This is unexpected as it is likely that the overall anaerobic component of individuals as reflected by minimum power would mean a better level of anaerobic fitness which would reveal an increase in the distance attained.

Given that certain anaerobic aspects improved over time (**Figures 1** and **2**) it is surprising that no significant relationships were found between these measures and performances. This is especially the case when the laboratory tests were designed to provide a simulation to match slalom competition, and to take account of the importance of incorporating an integrative approach i.e. simulation (2 minutes) and the standard WAnT (Jakeman et al.1994). The research design also utilised the best standardised time as a competition performance measure in order to eliminate some of the variance that might be introduced had penalties been included for skill errors.

Slalom canoeing is a complex skill, yet requires high levels of physiological fitness in order to cope with advanced whitewater on which international competition takes place. It requires the canoeist to accelerate, decelerate, change direction continually and turn through 360° frequently. A slalom competition to a skilled observer illustrates the importance of upper body power, and with the event lasting only about 120 seconds, a large anaerobic component. Given the nature of slalom canoeing it was hoped that the WAnT as a measure of anaerobic performance (Winter, 1991) which includes anaerobic power, may have been related to competitive performance. The results from this study do not support this hypothesis. Nor do the results support the notion that laboratory tests reflect competitive performance indices in elite international slalom canoeists. It may be considered that the laboratory measures we are using are still not sensitive enough to differentiate the physiological variables that could be critical to competitive performance. This study did attempt to reduce the influence of the skill factor, however it is still present but to what extent, it is difficult to ascertain at elite level. This could still be the overriding variable that is confounding the issues and possibly the results. Jakeman et al. (1994) has pointed out how difficult it is to make realistic measurements of the demands of multiple sprint sports and that their complexity is not easily replicated in the laboratory.

Vanderwalle et al. (1987) maintain that the magnitude of training effects, in elite athletes is sometimes smaller than the coefficient of variation of a physiological test. He also questions the validity of such tests for elite athletes if the only result is the value of maximal anaerobic power (or capacity) and it is likely that field tests would be just as useful.

This study has some weaknesses in that, as the result of a small sample size, the number of data points analysed was limited. This will always be a problem with elite groups which by definition are few in number. It is also worth noting that some subjects did complete more tests than others either because a piece of equipment failed over which there was no control (e.g. their own paddle shaft broke), or alternatively they felt too unwell to complete a test and to carry on might have interfered with their international preparation.

The study also has many strengths. It has been conducted with an elite group over a period leading into and through competition. The tests were conducted as near as possible to the competition dates so the most accurate estimation of the athletes' current physiological status was obtained without intruding into the subjects' competition preparation. Standardisation procedures have been used to take account of the variation in the number of data points for individuals and to make comparisons with the different lengths of competition courses. The 2 minute canoe test has attempted to simulate the actual movements of paddling a kayak and has, where possible, incorporated the subjects' own equipment.

However, notwithstanding the face value of these conclusions, the reservations made in respect of the sampling size and type suggest they be treated with caution when applied in the context of external validity.

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CHAPTER 3

Relationships between volume of training and both laboratory testing and international performance of elite slalom canoeists.

3.1 Introduction

All athletes are interested in improving performance. Similarly coaches are equally interested in this, but in common with scientists are additionally interested in the effects of training on performance. In particular they are concerned about way in which the training of the specific energy systems may enhance the probability of success.

The aim of the training process is to apply a series of stimuli that will displace the homeostasis of the organism's functional systems and provide a stimulus for adaptation. (Matveyer, 1981).

During competition slalom canoeing involves travelling down rough moving water as fast as possible. It also involves having to slow the boat and then to pick up speed again in addition to several changes of direction. On this basis it is similar to a multiple sprint event (Williams, 1987).

There have been a number of studies involving multiple sprint events which have attempted to gain a better understanding of the physiological mechanisms underlying the limiting factors to performance (Jenkins et al. 1994; Giatanos et al. 1991; Hamilton et al. 1991; Wootton and Williams, 1983). This understanding is seen as essential if optimal training is to be prescribed for athletes (Jenkins et al. 1994). Yet despite the importance of understanding training mechanisms there appears, at elite level, to be a paucity of information based on controlled studies involving optimal training, training specificity, recovery profiles and seasonal detraining. Sports scientists have found it difficult to persuade elite athletes to experiment with their training regimes. Thus, during the past century, exercise physiologists have had only limited impact on the training practices of successful athletes (Hawley et al. 1997).

Furthermore, reports that do exist generalise across sports and may have little relevance to specific aspects related to elite performers, and in particular little relevance to current needs in competition (Cox et al. 1995).

Bunc and Heller (1994) have commented that functional dispositions of trained athletes can be estimated from various ergometer tests (Astrand and Rodahl, 1986; Bergh et al. 1976; Bunc and Leso, 1993). However there is good evidence to suggest that specific functional metabolic adaptation may only be verified using specific performance tests (Astand and Rodahl, 1986; Bunc and Leso, 1993; Dal Monte and Leonardi, 1975; Larsson et al. 1988; Stromme et al. 1977); although others disagree (Apor et al. 1982).

This particular problem regarding specific performance tests has been the case with canoeists and studies have attempted to take this into account by using various cranking devices (Israel and Brenke, 1967; Tesch et al. 1976; Vrijens et al. 1975), a specified adjusted ergometer (Dal Monte and Leonardi, 1975; Heller et al. 1984; Larsson et al.1988) and an isokinetic pulley-trainer (Apor et al.1982).

Training stimuli in sports are usually described as a combination of training volume, intensity and frequency (Davies and Knibbs, 1971; Wegner and Bell, 1986). Surprisingly, in swimming, although much research has taken place (Costill,1985; Van Handel et al.1988) which of these three components maximises and enhances swimming performance remains unknown (Costill et al. 1991). Furthermore in relation to swimming, the mean intensity throughout a whole swimming season in relation to performance has not been studied (Mujika et al. 1995). Much of the research has also been based not on highly trained subjects but on untrained subjects in whom improvements are seen to be much greater (Mujika et al. 1995).

The importance of taking account of seasonal variations in key physiological parameters which may affect performance has been highlighted (Koutedakis et al. 1995). In a number of sports it has also been shown that physiological performance factors have been found to be lower during periods of competition than during periods of preparation e.g. - rowers (Hagerman and Staron, 1983), middle and long distance runners (Svenenhag and Sjodin, 1985), wrestlers (Song and Cipriano, 1984) and skiers (Koutedakis et al. 1992).

It is still not known whether fitness gained during the off season can be maintained in competition or whether the specialised training (based on technique and competition tactics only) is adequate for fitness maintenance and improvements (Koutedakis, 1995). A critical key to this may still lie in the widely used and accepted principles of periodisation to structure training programmes (Counsilman, 1968; Bompa,1983,1987,1989; Marlow, 1987; Harre, 1982). Although these and other researchers have written widely on the subject, Fry et al.(1992) maintains that much of this work is conjectural or experiential and not well controlled research, but rather informed opinion.

As a sport canoeing has had little published research. Most of the work to date has been related to flat water competition, nearly always based on laboratory testing and very seldom related to performance (Bunc and Heller, 1994; Ridge et al. 1972; Vaccaro et al.1984; Tesch et al. 1976; Lutoslawska et al. 1994). The few existing studies of slalom have looked at physiological characteristics and performance (in the laboratory), Sidney and Shephard (1973), and the energenetics of kayaking (field test) Pendergast et al.(1989). This latter study incorporated a cross-section of ability in its subjects, but the final results did not analyse and single out the elite from the inexperienced. Pendergast et al.(1989) also based their research model on the basis that irrespective of type of boat or type of competition the ability to paddle the boat at high speed is common and critical when competing. Such a claim does not take into account how speed is achieved down a slalom course and the ability to paddle fast is less critical than in other types of canoe competition.

The only work that appears to have been published in relation to elite level training in slalom has been an interview with a former DDR Canadian singles paddler Wulf Reinicke who defected and was able to explain his training diary to the USA coach (Endicott, 1980) Other work by Mantle et al. (1997) has reported on the relationship between laboratory tests and performance indices in international events. Both reports showed that there were few relationships between international slalom performance and the results of the laboratory tests over a whole season.

In slalom canoeing during the last four years, rules, boats and paddle design have changed. Along with this the length of the course tends to be shorter in time (approximately 120 secs.). The one unchanged factor is that each individual slalom competition makes different mental and physiological demands. This means it is difficult to train the physiological components in preparation for competition.

Considering the above it was decided to attempt to describe and record the physiological training of a group of world class slalomists, and to relate this to clinical tests and to international performance including an Olympic Games.

On this basis it would be possible to ascertain at least how much, and what type, of training is being undertaken by elite slalomists in the kayak class. The relating of this at various times of the year to laboratory tests and performance may then give some determinants of training requirements.

Therefore the specific purpose of this study, using elite level subjects over one competitive season including an Olympic Games, was threefold: firstly, to record training time in minutes spent on selected physiological parameters; secondly, to establish whether any of the laboratory tests related to the time spent on training the physiological components; thirdly, to identify whether any relationships existed between the amount of time spent training the physiological components and performance at international events.

3.2 Methodology

3.2.1 Subjects

Six world class male slalom canoeists gave their informed consent, and volunteered to take part in a monitoring process in preparation for the Olympic Games in 1992. Their physical characteristics were as follows: mean age of 25.83 years (sd $\pm$3.05); body mass (kgs) 68.96 (sd $\pm$3 .9); height (cms) 173 (sd $\pm$5.5); and sum of skinfolds 22.5 (sd $\pm$1.6) All had represented Great Britain at international events. The group contained the World Champion, the World Cup series champion, and the European Champion.

All volunteered on the understanding that they did not have to experiment with their training and that testing would take place when they thought appropriate. They were familiar with testing procedures, having been involved in such processes for the previous two years at the British Olympic Medical Centre. The author had coached each of them for periods ranging from six to twelve years.

3.2.2 Design

A non-experimental investigation was used in which two laboratory tests (Wingate and 2 Minute Canoe Sprint Test) were undertaken 5 times to monitor group changes with reference to the various physiological components being accumulatively trained.

The recorded training time of the various energy components was then related to the group results of the tests.

Then finally the group's recorded training times were analysed to ascertain any significant relationships to the group's standardised international performance results, including an Olympic games.

(N.B. not all competitors competed in every event as there was a limit as to the number of competitors allowed per nation e.g. the Olympic competition is restricted to 3).

The matching of the group accumulative monthly training and laboratory testing dates are given in **Table 1**. The group accumulative monthly training and performance dates are given in **Table 2**. It should be noted that the data reported from the laboratory tests is as near as possible to the monthly phases of accumulative training or as near as possible to International competiton dates. Although, ideally the testing should be conducted at exactly the same date each month this is not possible with elite athletes. Their training schedules, overseas training and competition dates have an affect on when testing is viable and in some cases appropriate.

Table 1 The matching of group accumulative monthly training with laboratory testing dates

Accumulative Training Month	Nearest Laboratory Testing Date
Oct. 91	11Nov.91
Oct. 91-Dec. 91	18 Dec. 91
Oct. 91-Feb.92	2 Marc. 92
Oct. 91-Apr.92	27 Apr. 92
Oct. 91-May 92	3 June 92

Table 2 The matching of group accumulative monthly training with international performance dates

Accumulative Training Months	Nearest International Performance Dates
Oct.91	27 Oct.91
Oct.91-Feb.92	22 Feb. 92
Oct.91-Apr.92	18 Apr. 92
Oct.91-May 92	30 May 92
Oct.91-June 92	27 June 92
Oct.91-Jul. 92	1 Aug. 92

3.3 Method

3.3.1 Measurement of Performance

Measurement of performance in sport can exhibit certain difficulties in research, particularly in those sports where it is impossible to compare an individual's performance directly against established records, standard times, or personal bests. Slalom canoeing falls into this category as each competition takes place over an unique gate sequence and the nature and flow of the water varies from event to event.

All the competitions in this study were classified as International 'A' events (ie highest grade). Each competitor has two competition runs and the best, inclusive of time penalties for hitting or missing gates, is the one that is counted. Penalties at this level of performance tend to be caused by technical errors rather than physiological inadequacies. It was decided therefore to use the best time taken from run one or run two as a measure of performance as this would eliminate any confounding variables such as technical errors. Not all subjects competed in every event due to variations in individual programmes, and also due to variations in selection or non-selection for the Great Britain Team.

Data were collected over one competitive season from 6 events, including the Olympic games. Official results were obtained from each event and used in the calculation of performance measures.

In order to allow for the variation in the nature and length of the different courses, and for the different abilities of the subjects, best raw times were transformed to standardised scores. To calculate this standardisation, the performance times were first adjusted relative to the performance time of the top twenty competitors. The mean and the standard deviation of the top twenty were calculated for each event. The mean was then subtracted from the performance time and the result then divided by the standard deviation.

A similar calculation was then used to allow for different individual abilities using the same method with the data that had already been standardised to allow for different race lengths.

This allowed for comparisons of performance for an individual over the race season and can be seen as a performance comparative measure as opposed to a performance outcome measure (Weinberg, 1990).

3.3.2 Measurement of Anaerobic Power

Anaerobic Performance was determined for the upper body using the Wingate Anaerobic Test (WAnT) (Bar-Or, 1981), utilising a Monark 864 cycle mounted on a platform and adapted to allow single arm cranking. Restraints were used to fix the lower body, and seating was adjusted to allow for individual body size and comfort.

A braking force of 7.5% of the subject's bodyweight (BW) was used. This percentage producing a resistance of 0.075Kg BW (Kaezkowski et al. 1982, Rotstein et al. 1982, Patton et al. 1985) with equivalent value for arms being 0.05Kg B/W (Paterson, 1981).

Each subject completed a five-minute standardised submaximal warm-up immediately followed by a five second sprint at the test load. A two minute rest was allowed before commencing the cranking action. Once a frequency of 60 $rev.min^{-1}$, with a low braking force to facilitate the control of cranking cadence, was attained a countdown from five was given and the full braking force applied. Maximal sprinting from start to finish, with no pacing, for 30 seconds was required (Bar-Or, 1987; Green, 1995).

The flywheel velocity was measured directly using a photocell which provided a square-wave pulse count for every four degree revolution. These signals were interpreted by a micro-computer interfaced to the device giving the power output for consecutive one-second intervals throughout the test. Three indices of performance were recorded; peak power (pp) in Watts; minimum power (mp) in Watts and total work (tw) completed in Kilo Joules.

3.3.3 The Two Minute Sprint Test

This test utilised an air-braked kayak ergometer (Modest, Denmark) that incorporated a magnetic sensor which displayed both the speed of the flywheel and the distance it travelled, together with the time lapsed. The subjects could see this display. The seat height was adjusted for each individual who could use his own paddle shaft. The ergometer was calibrated as per manufacturer's instructions.

An automated gas analyser (Jaeger Sprint, Hoechberg, Germany), was used to record respiratory parameters every thirty seconds during the testing while subjects inspired room air through a low-resistance two-way Rudolph valve. The gas analysers were calibrated with standard gases (5% O_2 15% CO_2, balanced with N_2) Spot checks were made on the calibration of the pneumotachygraph for volume flows up to 100 litres per minute using a 1-litre syringe.

The test protocol was designed to simulate typical slalom canoe races of the 1990s. Subjects warmed up for as long as they required and then tried to achieve maximum distance in the two minute period of the test (120 seconds being a typical time for international races). Pacing was left to the individual. Peak $\dot{V}O_2$ was recorded in $L.min^{-1}$, together with the distance attained. The excess post exercise oxygen consumption (Green and Dawson, 1993) was calculated for a period of 8 minutes post-test ($\dot{V}O_2Rec8$).

3.3.4 Recording of the Training

Training was recorded on standard forms in minutes for the particular workout. It did not include any warm up or warm down. The elite group understood the definitions of the various categories of training for the energy systems. These had a physiological basis to them, which had been derived from training theory, and used the experience of some of the most successful slalomists in the world. A number of these categories had also been verified using physiological testing procedures.

At the time this was regarded as the state of the art method of training with world class performers. It used slalom gates, where appropriate, in order to overload the energy systems using the specific muscles that are engaged in slalom.

A 'feelings' definition for practical purposes was also given in order that the slalomist should know the effect that these stresses were likely to be putting on his body, which helped to pace the training, in abbreviated form they were as follows:

Non-water training:-

This consisted of strength work using either conventional weights and/or an isokinetic canoe ergonometer.

Water training time:-

The total of any work performed in the kayak on water.

Creatine Phosphate (ATPCP):-

15/20 secs of short sharp fast slalom gates. Rests are in the ratio of 5 x the work time. Accumulation of muscular fatigue after several repetitions. - maximum muscular effort. Aim is to produce creatine phosphate in muscle, and to give speed and power and to delay the onset of lactate. This is regarded as speed training.

Anaerobic Threshold:-

20 to 30 minutes of continuous or intermittent work. Heart rate is higher than aerobic training, and heavier in effort near to the point of the onset of blood lactate accumulation. Heart rate set for each individual from lab test where the sharp increase was found in the lactate curve during a stepwise canoe ergometer test. Purpose is to train aerobic aspects of the skeletal muscle itself. Increasing heavy breathing on the verge of discomfort. Feeling of working hard. Start of tightness of arms and some fatigue. Difficult to talk. This is classed as aerobic local muscular endurance training.

Aerobic:-

30 minutes plus continuous or intermittent work at a comfortable level. Easy to continue at this pace . Low to medium heart rate. Purpose to increase the muscle

capillary density and the muscle oxygen transport system with some effect on the heart. Able to talk.This is seen as cardio-respiratory training.

Lactic Peak:-

60 to 70 secs. Short passive rests to retain lactate at high concentration level in the muscle. Purpose to train muscle to handle high levels of lactate and to train energy system to produce more energy. High heart rate. Very heavy breathing. Close to limit of muscular control. Increasing tightness in arms. General discomfort and slight nausea. Unable to talk. This is regarded as anaerobic power training.

Lactic Accumulation:-

45 secs. to 1 minute of work with active rest in the ratio 1: 5 and up to 1: 10. Purpose to generate a large total volume of lactate over the the whole session. This is in order to present that lactate to the liver and kidney, working and non- working muscles. All of this to promote removal training of lactate from the blood. Some discomfort as the session progresses. Able to talk as the rest takes effect. This is seen as anaerobic local muscle endurance training.

3.4 Analysis of the Data

Descriptive analysis of the training times for the group were calculated by taking the mean time per month for the various physiological components for the period October 1991-July 1992 and changing these to %'s. These were additionally classified with reference to the four preparation and competition phases adopted by the Great Britain Canoe Slalom Team (Mantle, 1990) which were:

phase 1, main preparatory (Nov/Dec)

phase 2, preparation (Jan/Feb/March)

phase 3, specific preparation and competition (April/May)

phase 4, specific competition (June/July)

To examine possible relationships between the physiological variables as measured by the 2 minute canoe test and the Wingate test and group accumulative monthly training, Pearson correlation coefficients were calculated for each pair of variables for the group.

Only the 1991 and 1992 laboratory test results were used for this analysis. This involved 6 testing variables, with 10 training categories over a period of ten months during which the subjects were tested on five separate occasions. The training measurements were athletic training, strength training, whitewater gates, flat water gates, general paddling, ATPCP, anaerobic threshold, aerobic, lactic peak, and lactic accumulation. This resulted in 300 correlation coefficients being calculated.

In order to examine the possible relationships between the group's accumulative monthly training and international performance, the performance data were standardised. Individual scores were standardised by subtracting the mean from the individual's score and then dividing by the individual's standard deviation. Using the results for all (five) individuals taken together the data were standardised as already described. (N.B. one individual was not selected for the International team and therefore no performance data exists for this subject). Pearson correlation coefficients were calculated for each pair of variables for the group. This involved relating the six International competitions (three competitors selected per competition) with 10 training variables, resulting in 60 separate correlations. Overall including the laboratory results and international performance 360 correlations coefficients calculated.

3.5 Results

Table 3 shows the mean %, range, and $\pm$ s.d. for the group's training over the period of one season leading into international competition and finally to the Olympic event in August 1992. The months that form the training phases 1 to 4 are also shown.

Table 3 Mean, Range and ± s.d. % training times for the various physiological components over one competitive season for the Great Britain men's kayak squad.

Month	**Athletic**	Range	sd	**Strength**	Range	sd	**WW Gates**	Range	sd	**Flt Gates**	Range	sd	**Gen Pdl**	Range	sd	**ATPCP**	Range	sd	**An. Th**	Range	sd	**Aerobic**	Range	sd	**Lactic Pk**	Range	sd	**Lactic Acc**	Range	sd
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Oct.91	6	0-10	4	16	8-27	7	29	2-35	5	3	0-7	3	6	1-13	4	12	2-26	10	13	6-24	6	12	6-17	5	3	0-5	2	1	0-3	2
Phase 1																														
Nov.91	5	3-8	2	11	8-14	3	29	2-33	4	6	1-15	5	9	2-15	5	9	2-20	8	12	5-27	8	13	7-17	4	1	0-2	1	4	0-13	6
Dec.91	6	3-8	2	12	11-16	2	28	2-34	7	5	2-18	6	8	0-12	4	7	1-14	5	10	5-19	5	14	19-19	3	3	0-6	3	5	1-12	5
Phase 2																														
Jan.92	6	3-8	2	15	11-22	4	27	2-34	5	3	0-8	3	12	3-19	6	7	1-16	6	9	5-16	4	12	7-16	3	3	0-6	2	6	2-14	5
Feb.92	7	2-14	4		9-18	3	26	2-33	5	3	0-9	3	11	4-16	4	10	2-23	8	8	5-12	3	12	7-21	5	4	3-5	1	6	3-12	4
Mar.92	5	1-12	4	11	8-15	3	37	3-54	9	4	0-13	5	6	2-11	3	8	4-12	3	10	5-15	4	7	4-13	3	5	3-6	1	6	2-11	4
Phase 3																														
Apl.92	2	0-7	2	7	0-12	5	41	3-63	12	6	1-11	4	9	4-12	3	10	4-17	6	7	1-15	5	7	3-12	3	6	2-8	2	5	3-8	2
May.92	6	0-23	9	11	6-12	2	33	3-42	5	3	0-9	3	11	8-20	4	8	3-14	5	9	5-11	3	10	7-13	2	4	1-5	2	5	0-11	4
Phase 4																														
Jun.92	9	0-24	9	7	0-14	4	39	3-59	10	4	0-9	3	7	3-14	4	7	1-15	6	8	0-17	7	6	7-14	2	4	0-5	2	6	0-11	5
Jul.92	11	2-47	18	3	0-6	2	33	0-44	17	5	0-9	3	8	4-14	4	8	0-12	4	7	0-15	6	14	4-50	8	4	0-7	3	7	0-13	5

Inspection of **Table 3** reveals the following % changes for the competition year:

Athletic training varies very little over the year but there is a reduction from an overall average of 6 down to 2 in the period of April 92. After this period it increases to a maximum of 11 immediately before the Olympic competition. However there is also the largest variance in range (2-47) and deviation (±18) among individuals at this high point in July. These are not unexpected results. Elite level slalomists do tend to differ in the way in which they train their aerobic systems. Some prefer to develop this area of training in the boat, whilst others prefer the change from paddling and conduct this work on the land. Competition venues vary in the facilities they offer, and often the slalomist can only train this particular physiological area when competing as access to the river may be restricted. Approaching competition the athletes (in common with athletes from other sports) will reduce the amount of training in order to rest the body and to regenerate all the physiological systems to enhance performance. This does present the competing athlete with a number of problems. Firstly they are used to training on a daily basis and this is part of their daily routine. This leaves a void in their day and they tend to get restless and bored. Secondly because they are less tired they tend not to sleep and this starts to develop its own problems both physically and psychologically. Athletic training in the form of running is relatively untaxing to highly trained subjects and fulfils all the daily needs thus alleviating all the aforementioned problems.

Strength training starts high in October 91(16) and then reduces to 3 in July, with little variance in the standard deviation. There are some larger ranges, though, in the period leading into major competitions in June, July and August. Strength training for slalom tends to start with a large number of repititions with light weights and then an increase in the mass and decrease the repetitions in order to develop power. Nearing competition there is a tendency to rest and to concentrate the training towards skill maintenance. However there is also a need to maintain power and therefore strength training, in any form, is required constantly throughout the year. There is personal evidence that strength does degenerate fairly rapidly in slalomists. Weight training is probably the easiest and most reliable way of monitoring the training state of strength. Fluctuation in the volume of training over a period of twelve months is likely to be the result of facilities that are available in competition venues and at training camps whilst on tour.

The largest % of all the training components is whitewater gates. This is the case in every month throughout the year The author would have expected this result and this does collaborate with his belief that one of the major factors of consistent performance at elite level is skill on whitewater gates. Inspection of Table 3 does show that the ranges are high for the squad, yet the standard deviations are reasonably consistent (± 6) except for the months leading into major competitions.(April, June and July) the major deviation among individuals in June (± 10) and July (± 17). Variation in the volume of whitewater gate training within individuals which is likely to account for the large range of scores in periods leading into competition, is often dependent on how confident the individual feels about their current form on whitewater gates. This is particularly the case when competing at an unfamiliar international site. Individuals do also vary in the amount of rest that they require before a major competition.

General paddling and flat water gate results remain fairly steady throughout the period with the standard deviation varying very little, except in general paddling in January (± 6) and flat gates in December (± 6). Both these training components are used to give variety in training and to maintain the feel of the paddle at a slower speed and in water that presents more resistance to the paddle blade, compared to whitewater. The volume of training in this area is relatively low, as it has become apparent that to compete at the major slalom sites throughout the world requires skills that can only be developed on advanced whitewater.

The training of the specific physiological components shows that the anaerobic threshold and aerobic areas have the greatest % of time spent on them, the aerobic component overall having a slightly greater %. The ATPCP training has the largest variance among the group, with ranges from 2-26% (October) and deviations from ± 3 to ± 10, March and October, respectively. Whereas the training of the lactic components shows that in most months twice as much time is spent on lactic accumulation as lactic peak. Standard deviations stay relatively low and consistent throughout the year (lactic peak ± 3-6; lactic accumulation ± 2-6). As aerobic components tend to take longer to develop than anaerobic parameters it would be expected that differences of the nature shown in **Table 3** would evolve. It is also suggested there has been some clearer evidence that aerobic training is likely to be more effective when the intensity is at the anaerobic threshold. Aerobic training is also likely to be the area of training in which slalom canoeists are willing to experiment. Training at around the threshold level, although not easy to monitor using heart rate, is one area where slalomists tend to be able to develop very accurate awareness for the intensity at which they feel they are exercising. Thus it is unlikely that they will stray from what they perceive to be the correct intensity, therefore unlikely to alter the training effect they require.

Training the aerobic components is important for it own sake, however, it is also apparent that to train any of the lactate systems does require the individual to be able to tolerate great discomfort. The athlete also needs to be highly motivated to sustain long periods of pain associated with this form of training. It is therefore not surprising that there is less volume recorded in these particular areas of training.

Table 4 The % of total training time allocated to Athletic and Strength development over the four phases of training during one competitive season

Month	Athletic %	Strength %
Pre-phase		
Oct 91	6	16
Phase 1		
Nov 91	5	11
Dec 91	6	12
Mean (Totals)	(6)	(12)
Phase 2		
Jan 92	6	15
Feb 92	7	13
Mar 92	5	11
Mean (Totals)	(6)	(13)
Phase 3		
Apr 92	2	7
May 92	6	11
Mean (Totals)	(4)	(9)
Phase 4		
Jun 92	9	7
July 92	11	3
Mean (Totals)	(10)	(5)

Table 5 The % of total training allocated to water training over the four phases during one competitive season.

Month	Whitewater Gates %	Flat Water Gates %	General Paddling %
Oct 91 (pre-phase)	29	3	6
Nov 91	29	6	9
Dec 91	28	5	8
Phase 1 Mean	**29**	**6**	**9**
Jan 92	27	3	12
Feb 92	26	3	11
Mar 92	37	4	6
Phase 2 Mean	**30**	**5**	**15**
Apr 92	41	6	9
May 92	33	3	11
Phase 3 Mean	**37**	**5**	**10**
Jun 92	39	4	7
July 92	33	5	8
Phase 4 Mean	**36**	**5**	**8**

Table 6 The % of training time allocated to the physiological components during the four phases over one competitive season

Month	ATPCP %	Anaerobic Threshold %	Aerobic %	Lactic peak %	Lactic Accm %
Oct 91 (pre-phase)	12	13	12	3	1
Nov 91	9	12	13	1	4
Dec 91	7	10	14	3	5
Phase 1 Mean	**8**	**11**	**14**	**2**	**5**
Jan 92	7	9	12	3	6
Feb 92	10	8	12	4	6
Mar 92	8	10	7	5	6
Phase 2 Mean	**8**	**9**	**10**	**4**	**6**
Apr 92	10	7	7	6	5
May 92	8	9	10	4	5
Phase 3 Mean	**9**	**8**	**9**	**5**	**5**
Jun 92	7	8	6	4	6
July 92	8	7	14	4	7
Phase 4 Mean	**8**	**8**	**10**	**4**	**7**

Examination of **Tables 4, 5, and 6** shows the changes in the amount of time spent on training and thus emphasis according to the particular phases of the competitive year. The various components stay fairly consistent throughout the phases (any changes of less than 2% are considered unimportant) but there are changes and differences between the periods which are:

October 91 and the main preparatory (phase 1)

strength (-4%)
ATPCP (-4%)
flat gates (+3%)
anaerobic threshold (-2%)
general paddling (+3%)
aerobic (+2%)
lactic accumulation (+5%)

Main preparatory (phase 1) and preparation (phase 2)

athletic (+3%)
anaerobic threshold (-2%)
general paddling (+6%)
aerobic (-4%)
lactic peak (+2%)

Specific preparation and competition (phase 3)

athletic (-4%)
strength (-6%)
white water gates (+7%)
general paddling (-5%)

Competition (phase 3) and specific competition (phase 4)

athletic (+6%)
lactic accumulation (+2%)
strength (-5%)
general paddling (-2%)

The changes over the various phases that are depicted in the **Tables 4**, **5**, and **6**, show what most slalom coaches would probably expect of a balanced training programme. There is a pre-training phase where individuals are either starting to train after a period of rest or possibly having to do some extra training if they are to meet the qualification standards. It would therefore be expected that there would be a certain amount of variation in this phase among individuals and the pre-training patterns are unlikely to be similar to other phases of the year, and are likely to vary from year to year. It would be expected that there would be increases in all the physiological components in the pre-training phase, as it is the time when the athletes are acclimatising their bodies in preparation for the heavy schedules ahead of them.

It is also worth noting that some of the substantial % increases in this period would depend on whether the slalomists' baseline was starting from zero. Therefore increases in, for example, lactic accumulation by 5% in phase 1 appears to be a vast increase, at this time of the year in such a taxing form of training.

The phases then tend to follow a pattern that would match what elite level paddlers through trial and error has been successful for them in previous years. This has not been scientifically evaluated but rather follows the general principles of slalom training that have evolved. Examination of the findings does show that the slalomists tend to build up the aerobic components first and this is followed by the anaerobic training. Strength training is attended to all year and there is a reduction of training overall nearing important competitions. However, the training components are not rigidly changed from one phase to another but rather there are gradual changes. There is also integration of the different types of training and there are some breaks with tradition in that there are aspects of lactic training taking place throughout the year. The variance that is seen, for example, in the competition phases is likely to be as a result of the availability of facilities at the competition venues as much as a definite decision concerned with desirable training regimes. Phase 3 and 4 demonstrates this where there is an increase in athletic training by 6%. Likewise in the months of January to March, phase 1, the weather plays a critical part in the type of training possible. Often there is increase in athletic work -outs in this phase as it is not possible to train on the whitewater. Critical areas of concern to the athlete are the need to focus on the whitewater skills nearer to competition and this is seen to be the case as shown by the % increase in this component in phase 3.

The Pearson correlation coefficient analysis pairing the various training times with the laboratory tests revealed levels of significance at the 5% level for two tailed tests as shown in **Table 7**

Table 7 Significant Pearson correlation coefficients at the 5% level between the time spent on the sub-divisions of training and the laboratory tests at specified dates

Variables	Correlation *(n)*	p-value	Test	Test Date
Total time/$\dot{V}O_2$	0.93 (5)	0.02*	2 Minute	18 Dec 91
Non-Water/$\dot{V}O_2$	0.90 (5)	0.04*	2 Minute	18 Dec 91
NonWater/Distance	0.91 (5)	0.03*	2 Minute	18 Dec 91
Water/$\dot{V}O_2$	0.89 (5)	0.05*	2 Minute	18 Dec 91
Strength/$\dot{V}O_2$	0.97 (5)	0.01*	2 Minute	18 Dec 91
Strength/Distance	0.94 (5)	0.02*	2 Minute	18 Dec 91
Strength/$\dot{V}O_2$	0.98 (4)	0.02*	2 Minute	2 March 91
Strength/Min.Power	0.85 (6)	0.03*	Wingate	27 April 92
Strength/$\dot{V}O_2$.Rec.8	0.98 (4)	0.02*	2 Minute	3 June 92
Flat Gates/$\dot{V}O_2$.Rec. 8	0.98 (4)	0.02*	2 Minute	2 March 92
Flat Gates/Distance	0.96 (4)	0.04*	2 Minute	2 March 92
Flat Gates/$\dot{V}O_2$.Rec.8	0.93 (5)	0.02*	2 Minute	27 April 92
Anaer.Thresh/.Min.Power	0.94 (5)	0.02*	Wingate	2 March 92
Anaer.Thresh/Distance	0.96 (4)	0.04*	2 Minute	2 March 92
Anaer.Thresh/TotalWork	0.85 (5)	0.03*	Wingate	27 April 92

(Number in brackets denotes the number of data points analysed) * = p significant < 0.05

The correlation coefficients shown in **Table 7**, reveal that:

significant correlations between amount of time training and laboratory tests amounted to six for December; five for March; three for April and one for the final test in June.

Correlations at the 5% level were found 12 times for the 2 minute test and 3 times for the Wingate test.

The time spent on the individual components showed that there were correlations 1x total time; 2x non water; 1x water; 5x strength; 3x flat gates and 3x anaerobic threshold.

The decrease in the significant correlations over the training phases which reduced from six in December to one in June, was not unexpected. Initially once training has commenced there is a relatively sharp positive response to this stimulus and then a levelling off. This may account for the results that have been presented in **Table 7**, and it also may account for the lack of any significant findings between the volume of training and the laboratory tests in November, as it is unlikely that enough training would have been accomplished at that point to have an effect.

The data reported here show that there was a greater number of correlations between the volume of training and the 2 minute test than the WAnT test. The 2 minute test has been designed to simulate competition allowing the paddler to choose their own pace and paddle. The movements and the resistance created by the canoe ergometer are regarded by the elite subjects as being very realistic. On this basis it may require a sum of all the various training components aerobically, anaerobically, strength, lactic, and ATPCP in order to create significant scores on this test. Whereas the WAnT is regarded as measuring the anaerobic component only. It may mean that this particular physiological component can only be developed to a certain level within the training regimes required in slalom canoeing.

The number of correlations between the time spent on the various training components and the laboratory tests as shown in **Table 7** is somewhat unexpected. The author in his role as coach to this elite group would have anticipated a greater number of correlations overall and in particular in the total amount of training time and various physiological parameters. It was also surprising to find the largest number of correlations related to strength. This is not an area of training that would be seen to underpin so many of the results across both tests. It was also surprising to see that flat gates featured as a major correlation variable, although it is acknowledged that it relates only to the 2 minute tests. The various aspects of lactate training do not appear at all and this is most unexpected, as it would have been predicted that some correlation would have emerged in relation to the WAnT. It is not absolutely clear, from a coach's point of view, for the reason for some of these results. However, they are discussed more fully in the final section of this chapter.

Table 8 shows the selected correlations between time spent training the components and international performance. It is seen that there were no significant correlations at the 5% level, but two correlations do come close to the 5% significance level. In particular flat gates in an event before the Olympics (30 May) and the Olympics itself (1 August). Strength and lactic accumulation with the event on the 22 February. These were the only group correlations between training and performance, that showed a close significant relationship.

Table 8 Selected Pearson correlation coefficients between the time spent on the sub-divisions of training and performance at specified dates.

Variables	Correlation	p-value	Performance Date
Strength	0.99 (3)	0.07514	22 Feb 92
Flat Gates	0.97 (3)	0.1631	30 May 92
Flat Gates	0.99 (3)	0.09629	1 Aug 92
Lactic Accm.	0.97 (3)	0.1453	22 Feb 92

(Number in brackets denotes the number of data points analysed)

3.6 Discussion

The data presented here describe the amount of time spent on the various constituents that make up the elite slalomist's preparation and competition year leading into and including the Olympics. Extensive correlation analysis has been applied to both the training components and the laboratory tests and the relationship between training and performance.

Astrand and Rodahl (1986) pointed out that training of appropriate frequency, duration and intensity will probably lead to improvements in performance. The problem lies in finding the appropriate level for the individual and then, as Jakeman et al. (1994) have stated, identifying the mechanisms that account for the improvements is a stern challenge. The need to identify these mechanisms of adaptation is particularly important because, by doing so, the effectiveness of training programmes can be increased. **Table 3** does show the high level of training that is undertaken by these slalom canoeists. This concurs with the findings of Krebs et al. (1986) that successful performers tend to train harder, longer and over a greater period of time. Billat (1996) also reported that the volume of training in marathon runners has to be taken into account when considering performance and does represent training status, and economy of effort and this is supported by, Conley and Krahenbulh (1980) and Morgan et al. (1989) However, more recently, Grant et al. (1997) found no correlation between 3 km racing and economy of effort.

The amount of time spent in the various phases (**Table3**) does show the varying % changes that take place. The October 91 month sees a low amount water and non water training, but this would be expected as it is the end of the season for most of the athletes. However some individuals still have to make the squad through a qualification event. It is the period when there is a mixture of rest and starting to build up in preparation for the heavy training load. This would account for the greater amount of non-water training consisting of strength work and athletic training (**Tables 3 and 4**). This would also explain the start of the aerobic training, which stays fairly consistent throughout the year with a small s.d. (**Table 3**) except for the March and April months where the competitors are coming up to the Olympic selection race in April 92 (**Table 6**).

Further inspection of **Table 3** indicates that the athletic training stays at a consistent % with little deviation until phase 3, where there is a sharp drop off in April and then a steady increase through to a peak of 11% in July (phase 4). This would be expected as the competitors reduce their training overall immediately before selection and increase time on the skills of whitewater gates. This is the case as the whitewater gates time in phases 3 and 4 increases to 37% (**Table 5**). There is also the problem that during international competitions there are fewer facilities for training and competitors try to maintain their overall conditioning by undertaking some athletic training.

The % changes over the four phases are in line with the periodisation that was first advocated by Matevyev (1981). The purpose of such cycles was to support a system of training that included annual repeats of volume and intensity. This was seen as necessary for the development of athletic abilities, some of which were seen as prerequisite to others (Bompa, 1983; Harre, 1982; Sleamaker, 1989). This can be clearly seen in the data presented in this study where the volumes of athletic and strength training are emphasised in the earlier phases, followed by the gradual change to the more intense and specific training for competition (**Table 3**). Such an approach is in line with training theory, that the varied tasks of training cannot all be worked on at the same time (Bompa 1983; Harre 1982). The reduction of training leading into important competitions phases 3 and 4 (**Tables 4, 5, 6**) and the variance in the s.d. and the extensive range seen for these periods depicted in **Table 3**, supports the findings that competition readiness cannot be maintained for the long periods, because of the stress from the increased intensity (Fry et al. 1991). However it is interesting to note that the subjects tended to maintain the strength training for most of the year and only reduced the volume in the final phase 4. This is somewhat contrary to what would be expected as Kraemer (1994) has indicated that strength suffers less from de-training than enzymatic based conditioning, such as endurance training.

The times spent on the specific physiological aspects of training over the four training phases show very little variation in the phosphate systems. The anaerobic threshold and aerobic training time reduce gradually, whereas the lactate sub-divisions stay relatively constant (**Table 6**). To some extent this is also surprising, as training associated with developing the phosphate and lactic systems is highly intense and is regarded in slalom as power and speed work. Normally it would follow on from an endurance base, and would be developed in the final 6-8 weeks of training. However, as slalom consists of many different speeds on the competition course and thereby is a partial multiple sprint event, then there may be a case for training many physiological systems over a whole season. However, the work of Jenkins et al. (1994), has shown that the sprint ability is increased with three weeks of training, and they suggest that enhanced glycogenolysis and some intramuscular buffering capacity may have contributed to the increase in power.

It could be suggested that, as Cox et al. (1995), have asserted, previous training studies which have attempted to make comparisons across all levels of skill and ability may have little relevance to current players at elite level. Certainly little is known about optimal training schedules, training specificity, recovery profiles and seasonal detraining in slalom canoeing.

The analysis conducted to establish the relationships between the time spent training the various physiological elements and the laboratory tests has provided some interesting findings. Previous studies on metabolic and circulatory adjustments to exercise have indicated the adaptations are specific to the type of training used (Astrand and Rodahl, 1986; Bunc and Leso, 1993; Bunc and Heller, 1984; Mygind et al.1991). Furthermore it has been deemed important that crossectional studies be conducted on the trained athletes so that the appropriate muscles are loaded during testing.

The laboratory tests in this study have attempted to do this and have taken account of the importance of this approach as emphasised in previous studies of paddlers (Bunc and Leso, 1993). The total amount of time training, surprisingly, only showed one positive correlation with the various laboratory tests (**Table 7**).

As slalom canoeing lasts only approximately 120 seconds and the training for the event would normally emphasise the anaerobic systems, it is surprising to see that the $\dot{V}O_2$ feature prominently The relationship between certain training modes and $\dot{V}O_2$, is very prevalent in the early part of the year and can be seen to be related to total time, non-water time, water time and strength. However except for the relationship with strength, $\dot{V}O_2$ does not feature as a correlation again. This would concur with the findings of O'Toole and Douglas (1995) who has proposed that $\dot{V}O_2$ max increases within the general population, but with the elite athlete there is little improvement. It is suggested that when these paddlers at the start of training are improving in this area of work, then they reach a plateau after which there is small improvement despite the level of training. However, perhaps its importance has been underestimated as Bunc and Heller (1994) have claimed it contributes 40% to the total energy expenditure of competitive canoeists in 2 minute races on flat water.

Strength is the most represented of all the training modes. It is seen to be prevalent in both the Wingate and the 2 Minute laboratory tests. It also spans all the months where correlations were found, it is the only area of training to do this. The programmes for strength training were designed by the author and the focus was clearly on strength and power, with no attention paid to endurance work. However it is not surprising to see the relationship between strength and minimum power and strength and distance (**Table 7**). The 2 Minute test does measure how far the subject travels in a set time. To attain maximum distance does require paddling at maximum speed for the whole period which is very dependent on strength. Likewise to attain a good rating of minimum power in the Wingate test requires cranking where power is sustained right to the end of the test. As has been described earlier, slalom canoeing involves many changes of pace. On this basis, contrary to the findings, it would have been expected that peak power in the Wingate test would have featured as a positive correlation with time spent on training.

Flat gate work is normally part of elite paddler's fine-tuning of paddle strokes. However, as the water is still it means that the paddler has to create all the momentum. This is in essence a form of power training in the boat. The amount of time spent on this form of training combined with the conventional strength training (**Tables 4 and 5**), constitutes the second largest volume of training time. So on this basis it might have been expected that time developing power would have been reflected in the test results. Of course the test results may reflect the subjects' training programme, rather than the demands of the sport (Anderson and Montgomery, 1988). This is to some extent is borne out in the work with slalom canoeists and the relationship between laboratory tests and performance indices by Mantle et al. (1997) who found no significant relationships between clinical laboratory tests and international performance.

The amount of time spent on whitewater gates forms the bulk of training for these subjects, and is seen as skill development rather than any physiological training. This supports the DDR's principles of training (Endicott, 1980). If this training is skill based then it would not be expected to relate to any physiological tests. Instead, particularly as it is such a large and important area of training, it would be expected to correlate significantly with performance. **Table 8** shows no such relationship. The reasons for this are not clear. Especially as a number of researchers have indicated that within homogeneous groups, once certain physiological thresholds have been reached, then other factors tend determine success (Bosco et al. 1994; Slievert and Rowlands, 1996; Schenau et al. 1996).

In terms of specific physiological parameters of preparation, only anaerobic threshold features as a correlating variable (**Table7**). This particular area also spans the two tests and appears in the testing period during phase 3. The anaerobic threshold was determined, using the non-linear increase in lactate acid from clinical tests for the setting of heart rates (Thoden, 1991). However, it is particularly difficult to maintain the set heart rate whilst paddling a kayak. On this basis it is surprising that this form of training had a number of correlations with the tests. Experience has shown that most of the subjects tend to paddle above the set heart rates, which may mean that they were in fact training another physiological system. But as the relationships are with distance, total work and minimum power it may be that time spent on the anaerobic threshold could be related as a contributing factor to these three measures.

The $\dot{V}O_2Rec8$ is seen to have positive significant relationships with strength in phase 4 and with flat gates in phases 2 and 3 (**Table 7**). It might be hypothesised that the increase in $\dot{V}O_2Rec8$ is a critical measure in slalom canoeists of their training for 'anaerobic capacity for energy production'. This being the maximum amount of ATP derived from rapid catabolism of phosophocreatine. This has been termed the maximum accumulated oxygen debt (Medbo et al. 1988). There is evidence that physical training leads to an increase in this measure, particularly where there is a need for a physiological and metabolical response to short term intense exercise (Medbo and Burgers, 1990).

The relationships between the various training categories and performance as depicted in **Table 8** have produced some unexpected results. The only physiological category to come close to being significant was lactic accumulation (r=0.97 p=0.14) yet this had not related to any of the laboratory tests. The purpose of this area of training is mainly to train the body to remove the lactate from the blood. From a coaching point of view this is seen as a means of being able to tolerate high levels of lactate during training rather than being competition specific. It has already been stated that there is the possibility that strength training and flat water gates may in fact be producing strength that can be applied in the slalom situation, and that combining these two areas of training does represent a large % of training time (**Table 3**). These two areas of training, also cover various phases of the competitors' year leading into the Olympic games. There were no positive correlations found for strength r=0.99, p= 0.08 (phase2) flat gates (phases 3 and 4) r=0.97, p=0.16; r=0.99, p=0.10 respectively, however they do come close at the 5% level.

As slalom is regarded as highly skill dependent, then it would have been expected that whitewater gates would have been the most likely to have correlated with performance.

Such a prediction would have supported findings of Bosco et al. (1994) that in skiing (not dissimilar to slalom canoeing in performance time and the problems presented to competitors in competition) skill is the most important characteristic and there is no conclusive evidence that physiological variables are good predictors of performance.

The findings from the present study have generated a number of hypotheses which have implications for future research. There is a need from a theoretical perspective to identify reliable models that focus on the interactive effect of skill and physiological training and the relationship with performance at international level in slalom canoeing. Alongside this further research is necessary to establish not only the most effective means of developing the physiological training but the threshold to which these components need training and the point where further training results in diminishing positive returns. This would result in the most effective way of training, but may also give greater opportunity for rest. It is also likely that this would result in not only the identification of seasonal variation in fitness, (Koutedakis, 1995) but the effect of detraining which is particularly relevant when attending international competitions for sustained periods of time.

From an applied perspective there is a need to develop stricter definitions for the physiological components for use in the field. These then need some easy system for monitoring and recording so that every training session has a definite objective underpinned by science. This would then contribute to the field of knowledge of volume, intensity and frequency to which reference has already been made.

This study has demonstrated that there maybe a positive relationship between strength and performance (they are close to being significant). On this premise it would be of value to develop water tests relating speed/acceleration from paddle force measurement of each blade stroke in whitewater. This is clearly important, as it is well known that flat water speed is not related to the speed generated by paddlers on a whitewater gate sequence taking exactly the same route through the gates.

The study presented here clearly has many limitations. The sample size is only just an acceptable level for statistical analysis and the large number of correlation calculations can only be regarded as giving an indication of possible hypotheses about associations between variables. The training data is also dependent on reliable recording by the elite subjects, and although the author was present at most of the training sessions there is still room for error.

However, the study also has many strengths. This is probably the first time within slalom canoeing that training has been delineated into the various sub-components and the volume of time spent developing these areas recorded, over a whole year including an Olympic Games. It has ecological validity. Furthermore, all the subjects were elite and the study attempted to establish relationships between training and the effect on laboratory tests along with the relationship to international performance. However not withstanding the face value of the results they need to be treated with caution in view of the limitations already stated, particularly when applied in the context of external validity

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CHAPTER 4

Generalizability of anxiety performance relationships to elite slalom canoeists.

4.1 Introduction

Elite world class performers by definition are successful. However, some elite performers are more successful than others. This success is often characterised by being able to perform at the highest levels in situations that are deemed pressured. Part of this pressure may be translated into anxiety which is commonly thought to impair performance (Burton, 1988). On this basis anxiety has received a considerable amount of research attention (but not at elite level). This research has served to demonstrate that the relationships between anxiety and performance are complex, and may have raised more questions than answers (Jones, 1995).

Historically, the research in this area has used clinical and educational test anxiety conceptualisations to show that anxiety could be split into two sub-components: psychic and somatic anxiety (Hamilton, 1959; Buss, 1962; Liebert and Morris, 1967). These components were later re-labelled by Davidson and Schwartz (1976) within a proposed multi-dimensional model as cognitive and somatic anxiety. This was in contrast to the earlier work which had used Speilberger's (1966) State-Trait Anxiety Inventory (STAI), measuring in particular the state-element which was generalised and undifferentiated incorporating both physiological and psychological parameters (Klovora, 1974; Martens and Gill, 1976). The principal contention of these studies was that high levels of state anxiety interfere with performance.

Other research indicated that there was an area of state anxiety that could be zoned and would provide the optimal person-environment interaction for enhanced performance (Hanin 1980, 1986, 1989). Conceptionally, this Zone of Optimal Functioning (ZOF) is appealing to practitioners (Gould and Krane, 1992). However, it was originally based on an unidimensional approach and generally used STAI, which is not sports specific, as its central measuring instrument (Jones, 1995). More recent research on the ZOF model has utilised multi-dimensional measures of anxiety (Gould et al. 1993; Krane, 1993; Raglin and Turner, 1993; Woodman et al.1997).

It was the non-specific nature of measuring instruments like the STAI that led Martens (1977) to develop sport-specific anxiety tests. Initially, he produced the Sport Competition Anxiety Test (SCAT), a test of trait anxiety, then the Competitive State Anxiety Inventory (CSAI) (Martens et al. 1980) which with modification became the CSAI-2. This is a multi-dimensional means of measuring pre - competitive state anxiety. This measuring instrument incorporates competitive state cognitive and somatic anxiety sub-components, together with self -confidence (Martens et al. 1982; Martens et al. 1990).

Although the CSAI-2 has been used quite extensively in research because it is sports specific and also multi-dimensional in structure, it is seen to have limitations in its current format. Parfitt et al. (1990) have pointed out that the CSAI-2 only measures the intensity of the particular anxiety symptoms or cognitive intrusions. Other researchers have examined the frequency and directional interpretation (negative versus positive) of these symptoms (Jones and Swain, 1992; Jones, 1993; Jones et al.1994). The overall finding from this work would indicate that a larger proportion of performance variation can be accounted for by directional interpretation than by intensity.

Furthermore, multi-dimensional anxiety theory makes specific predictions about how anxiety affects performance: cognitive anxiety should have a negative linear relationship; somatic anxiety should have an inverted-u shaped (quadratic) relationship; and self-confidence should have a positive linear relationship (Martens et al. 1990). These have been derived from the concerns of performers which have been conceptualised as: concerns about performing well and the consequences of failure (cognitive anxiety) ; perceptions of physiological response to psychological stress (somatic anxiety) ; and belief that the task can be completed (confidence).

Various studies (Jones and Cale, 1989; Parfitt and Hardy, 1994) have explored the relationships between these various sub-components and performance. Results from these studies have shown that cognitively anxious subjects show an improvement in their mean performance during the days leading up to the competitions provided somatic anxiety and physiological arousal are low. When somatic anxiety and physiological arousal were high on the day of the competition then mixed positive and negative effects were recorded (depending on the nature of the task). Such findings have led recent researchers to attempt to clarify the relationship between the sub-components of cognitive anxiety, physiological arousal (not somatic anxiety) and performance, in the form of a three-dimensional catastrophe model (Fazey and Hardy, 1988; Hardy, 1990; Hardy and Parfitt, 1991). Additional research by Hardy (1996) has examined the 'cusp' and 'butterfly' catastrophe models in comparison with the multi-dimensional anxiety theory models . The results would seem to indicate that there is more support for an interactive (catastrophe) model than for the additive (multi-dimensional anxiety theory) models. However, some refinement and control of confounding factors is still needed to increase confidence in these initial findings.

This latter study involved a shift from laboratory to applied field studies, and also a move towards subjects who were higher level performers. However very few studies have been carried out with elite (i.e. world class) performers in the field. Although problems always exist in attempting to use elite populations in the field these are exacerbated by using techniques which intrude into their normal functioning. If we accept that high level performers have found a way of producing good performance over a period of time, then examination of their psychological state prior to and during performance may provide some useful information. However, criticism has been levelled at the way in which anxiety and performance have been measured and there is a call for more sensitive indicators to be used (Gould et al. 1987; Martens, 1977; Sonstroem and Bernardo, 1982). The main areas of concern have been that the researchers have not used individuals' precise performance measures, but rather imprecise competitive outcome measures, or alternatively performance measures that have employed inter-individual comparison. These failed to allow for differences in skill levels. The results could, for example, have been caused by mediating factors such as anxiety or alternatively because of differences in skill level.

One of the major issues in anxiety research concerns its relative failure to predict a substantial amount of performance variation. This leaves a number of questions and problems that need addressing (Jones, 1995). Among these is the rather imprecise way that cognitive and physiological symptoms constitute a state which supposedly reflects anxiety, and the consequent assumption that this is detrimental to performance. Jones (1995) is also concerned that anxiety and performance have not been measured during the actual performance although, in most cases, this is impractical. Likewise criticism has been made that global performance measures have been utilised and these are not sensitive enough to single out the effects of anxiety (Eysenck 1984, 1992). There is a need for development of standardised, reliable, ecologically valid and sensitive performance measures (Jones, 1995) which may be very difficult to establish as an ongoing measure in the field, particularly with elite performers.

The purpose of this study was to re-visit some of these issues using elite level subjects over two competitive seasons at international events including an Olympic Games: firstly, by assessing their pre -competitive state anxiety; secondly, by measuring the effect of this anxiety on the performance within a multi -dimensional framework; thirdly to explore the validity of Hanin's (1980) Zones of Optimal Functioning hypothesis.

4.2 Methodology

4.2.1 Subjects

The subjects were five elite slalom canoeists, all of whom had won individual and team medals in international 'A'; world championships, world cup or olympic competitions. They were aged between 21 and 30 years. All the subjects were personally known by the author who was also their coach. The subjects were told that the purpose of the study was to examine the relationship between certain psychological parameters and slalom performance. All subjects gave their informed consent to take part in the study.

4.2.2 Design

A non-experimental field investigation was used in which cognitive anxiety, somatic anxiety, self-confidence and performance were monitored at 20 international races including an olympic event during the period from October 1990 to August 1992. Prior to these internationals, subjects became familiar with the procedures, by undertaking the same measurements at three domestic events. This then enabled the subjects to incorporate the procedures into their normal pre-race warm up routines without causing any interference.

4.3 Method

4.3.1 Measurement of Performance

Measurement of performance in sport can present certain difficulties for researchers, particularly in those sports where it is impossible to compare an individual's performance directly against established records, standard times, or personal bests. Slalom canoeing falls into this category as each competition takes place over an unique gate sequence and the nature and flow of the water varies from event to event.

All the competitions in this study were classified as International 'A'events (i.e. highest grade). Each competitor has two competition runs and the faster of the two, inclusive of time penalties for hitting or missing gates, counts. Not all subjects competed in every event because of variations in individual programmes, and variations in selection or non-selection for the Great Britain Team. Data were collected from at least 5 events for each subject, ranging up to 14 for two subjects. Official results were obtained from each event and used in the calculation of performance measures.

In order to allow for the variation in the nature and length of the course, and to allow for comparisons of performance for each individual subject over the race season, best raw times were transformed into standardised scores in various ways (see Results section) (Weinberg, 1990).

4.3.2 Measurement of Anxiety

Martens et al. (1990) CSAI-2 questionnaire was used to measure three pre-competitive components of state anxiety, namely somatic and cognitive anxiety and self-confidence. The scale comprises 27 items with 9 items in each of the three sub-scales. Responses to each item are scored on a Likert Scale ranging from 1 (not at all) to 4 (very much so) about how they, the subjects, feel immediately prior to competition.

CSAI-2 sub-scale scores were standardised according to procedures proposed by Sonstroem and Bernardo (1982) and Burton (1988) in order to negate intra-individual subject response variation.

The CSAI-2 has been used extensively in research concerned with anxiety and performance in sport. A high degree of internal consistency and validity for the sub-scales has been reported (Martens et al. 1990) with alpha coefficients ranging from 0.79 to 0.90. Martens et al. (1990) have further demonstrated through factor analysis that the three sub-components of state anxiety are relatively independent of each other, that is orthogonal.

4.3.3 Measurement of the Zone of Optimal Functioning

The ZOF was calculated for each individual using the standardised performance and standardised CSAI 2 scores. To establish each individual's ZOF, each subject's best performance score was matched with their CSAI-2 sub components score for cognitive and somatic anxiety at that particular time. This established the ideal state for the individual in line with Hanin's (1980) recommendations. The optimal zone of anxiety was then created 0.5 standard deviations either side of this score.

The sub components were then divided into three levels :

1. Below Zone, 2. In Zone, 3. Above Zone. This yielded 50 scores for subsequent analysis. It should be noted that the analysis had to omit each subject's best performance score and corresponding anxiety score from the data set. This was essential to prevent unfair bias in the results as these scores were used to derive the classification of the boundaries of the zones. As this part of the study was mainly concerned with pre-competitive anxiety, only the cognitive and somatic anxiety scores were used in the analysis.

4.4 Procedure

Each subject was asked to complete the CSAI-2 questionnaire 15 minutes before the start of

Run 1 and Run 2 respectively. They did this sitting in their kayak on the water in the warm-up area.

4.5 Results

The 'raw' performance times were adjusted for different race length by subtracting the mean performance time of the top 20 in each race and then dividing by the standard deviation of the performance time of the top 20 (Performance time – mean score)/s.d. (Sonstroem and Bernardo, 1982). A second measure was also created in exactly the same way but using just the top 10 times.

A similar calculation was then used to allow for the different individual abilities using the same method with the data that had already been standardised to allow for the different race lengths (**Table 1**). This table also shows each individual's best (Min) and worst (Max) scores. This then gives the range of performance scores across the number (N) of international races over a two year period. This allowed for comparisons of performance for an individual over the race seasons and can be seen as a performance comparative measure as opposed to a performance outcome measure (Weinberg, 1990).

The advantage of these standardisation procedures is that it allows comparisons of an individual's performance relative to the top twenty performers over a number of events. In effect it is allocating a unit of difficulty consistently across courses and alleviates the necessity of calibrating the true performance time of a particular course. The s.d. does vary according to the difficulty of the course. The more difficult the course the greater the s.d. and vice versa. However, this form of standardisation does have limitations. It relies on the top twenty competitors producing consistently good performances over a period of time. Despite these limitations it probably represents the most accurate method of inter-individual standardisation in a competition where the performance time varies from race to race.

Table 1. Individual standardised international performance scores

Subject	Min	Max	Number of international events completed
1	-1.85	2.92	14
2	-1.17	2.57	14
3	-0.99	2.99	13
4	-1.40	1.33	9
5	-0.90	1.18	5

Each component of the CSAI-2 was then standardised, for each individual, by subtracting the individual's mean sub-component score (**Table 2**).

Table 2 Intra-individual CSAI-2 Sub-components statistics

Subject	Raw Scores				Standardised scores		Number of CSAI-2 completed
			Cognitive		Cognitive		
	Min	Max	Mean	s.d.	Min	Max	
1	11	22	15.14	3.48	-1.19	1.97	14
2	10	20	15.36	3.00	-1.78	1.55	14
3	9	19	12.46	2.73	-1.27	2.40	13
4	11	19	15.44	2.24	-1.98	1.59	9
5	8	13	11.2	1.92	-1.66	0.94	5
			Somatic		Somatic		
1	9	18	13	2.72	-1.47	1.84	14
2	11	19	13.71	2.70	-1.01	1.96	14
3	10	22	15.23	3.06	-1.71	2.21	13
4	10	12	10.78	0.83	-0.93	1.47	9
5	9	13	11.6	1.95	-1.33	0.72	5
			Confidence		Confidence		
1	27	34	30.64	2.10	-1.736	1.6	14
2	27	35	31	2.25	-1.775	1.78	14
3	21	36	29.23	4.89	-1.685	1.39	13
4	26	33	30	2	-2	1.5	9
5	29	34	29.8	0.84	-0.956	1.43	5

Following these intra-individual standardisation procedures, data were collapsed across subjects to yield a total of 55 data points. The analysis then concentrated on identifying any relationships between the components of the CSAI-2 (Predictor Variables) and standardised performance (Dependent Variable) which included Top 10 and Top 20 adjusted scores; competitors' results; Run 1 and Run 2 separately; Total score (i.e. Time + Penalties); Penalties only; and finally best Standardised Time only.

In all of these cases no statistically significant trends were shown. The summary statistics that are reported here along with the Figures are for the Best Standardised Time Score and the components of the CSAI-2. The R^2 for other dependent variables was similar.

In line with other studies which have examined Martens et al.'s (1990) predictions regarding the relationship between performance and the CSAI-2 both linear and quadratic analyses was utilised. (Burton, 1988; Gould et al.1984; Gould et al. 1987).

Table 3 Regression analysis of standardised performance on CSAI - 2 cognitive, somatic and confidence subcomponents

	Linear Performance / Cognitive			Linear Performance / Somatic			Quadratic Performance / Somatic			Linear Performance/ Confidence		
Subject	R^2 – value	F – value	p – value	R^2 – value	F – value	p – value	R^2 – value	F – Value	p – value	R^2 – value	F – value	p – value
1	0.02	0.25	0.63	0.01	0.07	0.8	0.1	0.64	0.54	0.	0.	0.99
2	0	0.03	0.86	0.01	0.07	0.8	0.13	0.83	0.46	0.11	1.53	0.24
3	0	0.05	0.83	0.02	0.24	0.63	0.11	0.63	0.55	0.06	0.72	0.41
4	0.03	0.25	0.63	0.36	3.89	0.09	0.36	1.67	0.27	0.03	1.19	0.68
5	0.07	0.21	0.68	0.07	0.22	0.67	0.37	0.58	0.64	0.05	0.15	0.75
All	0	0.01	0.9	0.01	0.64	0.43	0.06	1.78	0.18	0.02	1.34	0.25

An inspection of **Table 3** reveals:

1). Regression of standardised performance time on standardised cognitive anxiety score for each of the 5 subjects separately showed no statistical evidence at the 5% significance level. In order to be absolutely certain there was very limited statistical evidence of any relationship between performance and cognitive anxiety the data were subjected to further analysis at the 10% level of probability. This also proved to be non-significant (also see **Figure** 1).

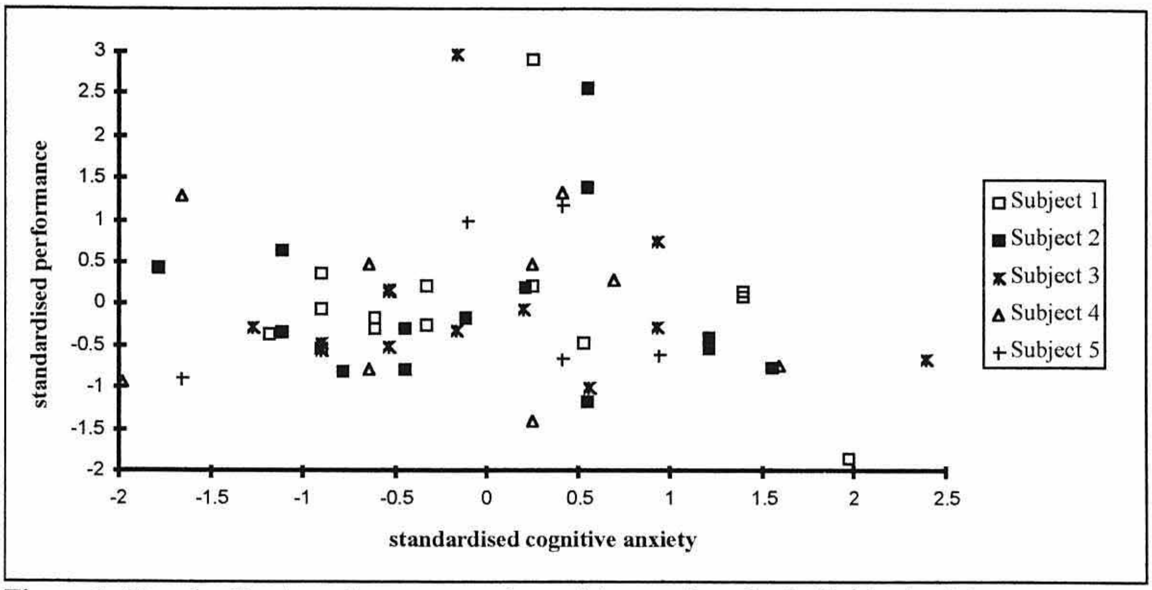

Figure 1. Standardised performance and cognitive anxiety for individual subjects

2). Regression of standardised performance time on standardised somatic anxiety score for each of the 5 subjects separately and all subjects taken together showed statistical evidence at the 10% significance level of a relationship for just one individual, $t_7 = 1.79$, $p = 0.09$, (subject 4). Addition of a squared term for somatic anxiety score into the model, to allow for a possible quadratic model, did not significantly (at the 10% level) increase the percentage of variance accounted for any one subject. However the change for all the subjects was just significant at the 10% level $t_{57} = 1.70$, $p = 0.095$.

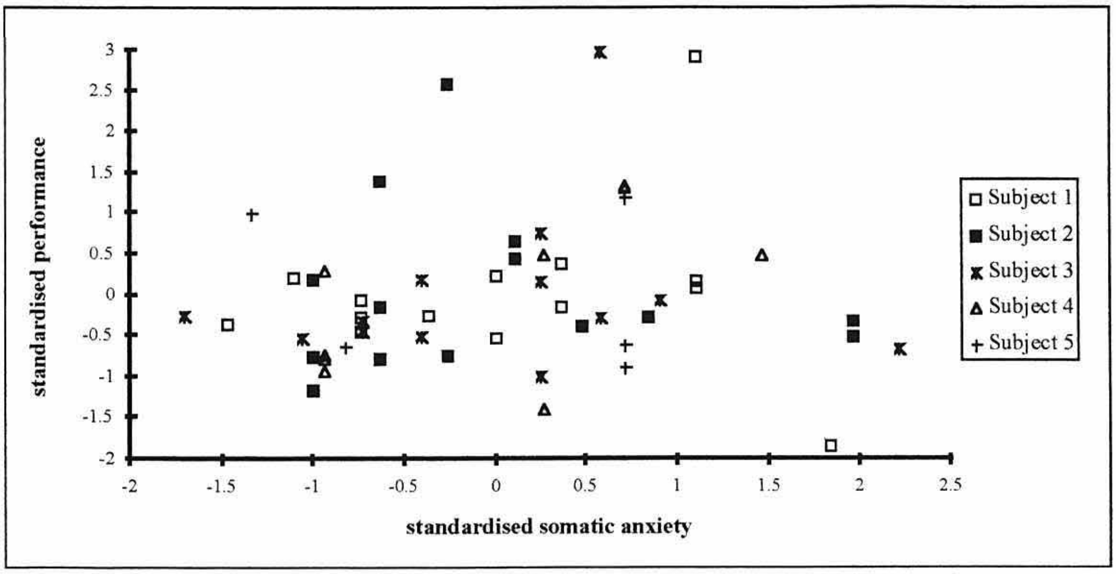

Figure 2. Standardised performance and somatic anxiety for individual subjects

Regression of standardised performance time on standardised confidence score for each of the 5 subjects and all subjects taken together showed no statistical evidence at the 10% significance level of a relationship for any of the subjects or all of the subjects taken together (see **Figure 3**).

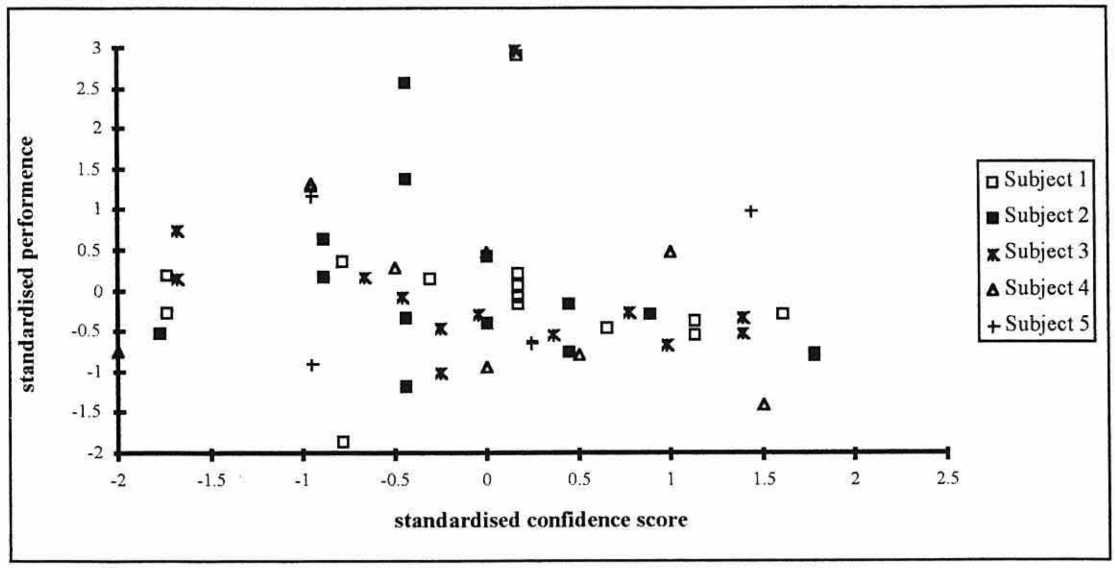

Figure 3. Standardised performance and standardised confidence score for individual subjects

Analyses of variance - **Table 4** - which split each of the component anxiety scores into below zero, or equal to or above zero, categories (corresponding to an individual having a below or above average score, where zero = an individual's mean anxiety score) showed no significant difference (at the 10% level) between these categories in mean standardised performance score for individual subjects or all subjects taken together. The results in this table do show a relatively even spread of anxiety scores above and below average as indicated by the numbers in italics. Additionally, when these catergorical variables for cognitive and somatic scores were considered jointly for a two-way analysis of variance model the interaction term was not significant at the 10% level (individual subjects and all subjects).

Table 4. Summary of one factor analyses of variance for standardised performance

CSAI Sub-component	Subject	Mean Standardised Performance Measure for Standardised CSAI sub-component < 0		Mean Standardised Performance Measure for Standardised CSAI sub-component ≥0		Standard Error of difference between means, *t*-values, and *p*-values		
			N		*N*	s.e.d.	*t* - value	*p* - value
Cognitive	1	-0.14	*8*	0.18	*6*	0.56	0.57	0.58
	2	-0.19	*7*	0.19	*7*	0.55	0.69	0.51
	3	0.15	*8*	-0.24	*5*	0.58	0.68	0.51
	4	-0.42	*3*	0.21	*6*	0.72	0.87	0.42
	5	0.05	*2*	-0.03	*3*	1.05	0.1	0.94
	All	-0.08	*28*	0.09	*27*	0.26	0.64	0.52
Somatic								
	1	-0.19	*8*	0.25	*6*	0.55	0.81	0.44
	2	0.06	*8*	-0.08	*6*	0.56	0.24	0.81
	3	-0.32	*6*	0.27	*7*	0.55	1.07	0.31
	4	-0.55	*4*	0.44	*5*	0.61	1.6	0.15
	5	0.17	*2*	-0.11	*3*	1.04	0.28	0.8
	All	-0.17	*28*	0.18	*27*	0.26	1.35	0.18
Confidence								
	1	-0.27	*5*	0.15	*9*	0.57	0.75	0.47
	2	0.39	*7*	-0.39	*7*	0.51	1.55	0.15
	3	-0.1	*7*	0.12	*6*	0.58	0.37	0.72
	4	0.28	*3*	-0.14	*6*	0.74	0.57	0.59
	5	0.14	*2*	-0.09	*3*	1.04	0.22	0.84
	ALL	0.08	*24*	-0.06	*31*	0.26	0.51	0.62

Numbers in Italics = number of scores Individual Subject has < or ≥ than 0

Recent research has provided partial support for an interaction model of cognitive and somatic anxiety in relation to performance within a multi-dimensional framework (Edwards and Hardy, 1996; Woodman et al.1997). In order to test for any interaction between pairs of anxiety components, categorical variables for cognitive and somatic anxiety scores were considered jointly using a two-way analysis of variance model (**Table 5**). The interaction term was not significant at the 10% level (all subjects).

Table 5. Summary of 2 factor analysis of variance

Subject	Standardised Cognitive Anxiety	Standardised Somatic Anxiety				Residual Mean Square F value and p value for interaction			Residual degrees of freedom
All		< 0	*n*	≥0	*n*	RMS	F	P	
	< 0	-0.32	*17*	0.28	*11*	0.93	1.08	0.13	51
	≥ 0	0.06	*11*	0.11	*16*				

n = No of Individual Subject's scores < or >/= to 0

In order to test the usefulness of Hanin's ZOF hypothesis standardised performance data was analysed using a two way Analysis of Variance model with the classification factors being related to the zones of optimal functioning for cognitive and somatic anxiety. Specifically, a classification factor was defined for each of cognitive and somatic anxiety levels of each factor being 'Below optimal zone', 'In optimal zone', and 'Above optimal zone'.

As the Analysis of Variance is unbalanced (unequal numbers of observations in the nine cells) the main effect of being 'Below', 'In' or 'Above' optimal zone for cognitive anxiety was found after adjustment for any effect of being 'Below' 'In' or 'Above' the optimal zone for somatic anxiety (and vice versa). **Tables 6 and 7** summarise the findings which clearly show:

1) there was no evidence of an interaction between the factors for cognitive and somatic anxiety. ($F_{2,45} = 0.82$, $p = 0.52$).

2) there is some weak evidence of a difference in the mean performance results according to whether the cognitive anxiety score was 'Below', 'In' or 'Above' the Zone of Optimal functioning ($F_{2,45} = 3.11$, $p = 0.05$). Bonnferoni's adjustment for the three comparisons between the adjusted means suggested that there is only really evidence of a significant difference between the results for being classified in the 'In Zone' compared to being classified in the 'Above Zone' ($p = 0.06$ with Bonneferoni's adjustment). More importantly, it appears that performance is worse 'In Zone' .

3) there is no evidence of a difference in the mean performance results according to whether the somatic anxiety score was 'Below', 'In' or 'Above' the 'Zone of Optimal Functioning' ($F_{2,45}=0.64, p=0.53$), indeed the mean performance for the 'In Zone' is worse than that for 'Below' or 'Above the Zone'.

Table 6. Inverse Means (M) and standard deviations (sd) of standardised performance for below, in and above zone (of optimal functioning)

	Below Zone	In Zone	Above Zone
Cognitive Anxiety	M= 0.17 sd= 0.88 n= 31	M= 0.80 sd= 0.86 n= 10	M=-0.24 sd= 0.76 n= 9
Somatic Anxiety	M= -0.08 sd= 0.76 n=25	M= 0.45 sd= 1.08 n=13	M= 0.20 sd= 0.97 n= 12

n = Number of subjects placed in those zones. (M is on inverse scale, Minus M score = better performance).

Table 7 Inverse Means (M) and standardised deviations (sd) of standardised performance for combinations of zones of cognitive and somatic anxiety

Somatic Anxiety	Cognitive Anxiety		
	Below Zone	In Zone	Above Zone
Below Zone	M= -0.08 sd= 0.62 n=20	M= 0.01 sd=0.15 n=2	M= -0.13 sd= 0.96 n=3
In Zone	M= 0.19 sd=2.02 n= 6	M=0.82 sd=0.27 n=5	M= 0.28 sd=1.62 n=2
Above Zone	M= 0.18 sd=0.21 n=5	M= 1.28 sd=1.73 n=3	M= -0.58 sd= 0.02 n=4

n = Number of subjects placed inside those zones. (M is on inverse scale, Minus M score = better performance).

4.6 Discussion

The analysis of the data has been extensive, examining anxiety variables that might have been related to performance. Variables included not only all the CSAI-2 sub-components but also the variables concerned with first and second runs, penalties only, total scores, fastest times, top 20 and top 10 international results. In all of these analyses there have been no significant relationships at the 10% level except in the case of Subject 4 with respect to somatic anxiety. When the squared term for somatic anxiety was added (for all subjects) then the level of significance was just reaching 10%. Additional examination of the outlier data points revealed no hint of a relationship between anxiety and performance. However, the number of analyses carried out meant there was an increased probability of Type 1 errors. The analyses may be regarded as exploratory in nature generating hypotheses for further study.

The summary statistics reported have focused on the fastest time achieved by the paddlers during a competition. This is seen among the international slalom athletes as critical for high level performance. Although errors are heavily punished by adding time penalties, being able to produce a fast time is critical and is one of the major criteria used by coaches for evaluating a potentially good performer. However, it might be assumed that any performer showing particularly high levels of anxiety or a lack of confidence may be prone either to producing slow times or making more penalty errors. The results of this study show no clear evidence of any such relationship either within individuals or across the group (see **Tables 3 + 4** and the statistical analyses reported earlier). This does not support the notion of multi-dimensional anxiety theory (Martens et al. 1990) which contends that cognitive anxiety is likely to be consistently and negatively related to performance.

The results of this study (**Table 3**) were generally inconsistent with the findings of Burton (1988) who demonstrated negative, quadratic, and positive relationships between the CSAI-2 anxiety components of Cognitive anxiety, Somatic anxiety, Confidence and Performance. Likewise, although the cusp catastrophe model (Fazey and Hardy, 1988) allows for an interaction effect between the sub-components of the CSAI-2 as compared to seeing these sub-components as having only additive effects on performance, there was no evidence of any interactive effects in the present data **(Table 5 and 6)**.

A considerable amount of research has indicated the effect of anxiety upon performance. Work by Hardy (1996) and Edwards and Hardy (1996) suggests that under high physiological arousal, cognitive anxiety may be detrimental to performance, whilst the opposite is true under low physiological arousal. Similarly, work by Hardy and Parfitt (1991), and Hardy et al. (1994) has supported the notion that cognitive anxiety can be beneficial to performance, depending on the levels of physiological arousal experienced. Further support for this is provided by Eysenck (1979, 1982) who implied that elevated anxiety has the potential to create a positive or negative effect upon performance by way of increased effort and working memory capacity respectively.

So although the facilitative / debilitative influence of anxiety upon performance did not emerge directly from the results of this study, it is possible the slalomists were able to block out any of this influence. Table 1 shows the high levels of self-confidence recorded. This inference is consistent with Carver and Scheier (1986, 1988), who proposed that anxiety is facilitative provided that the individuals' expectations of being able to cope and attain their goals are favourable. However, when individuals' expectations of attaining their goals are low then the converse would apply and anxiety could be debilitative.

Hardy (1990) has also suggested that self-confidence may be a key factor in guarding against detrimental effects of anxiety. He further suggests that, within a multi-dimensional anxiety model, self-confidence may be a better predictor of performance than cognitive and somatic measures. The main thrust of this argument is that self-confidence moderates the interactive effects of cognitive anxiety and physiological arousal.

Research in connection with the felt and preferred levels of arousal suggests that the larger the discrepancy between these two variables, the higher the indicator of stress experienced (Svebak and Murgatroyd, 1985). Further research in this area with squash players (Cox and Kerr, 1989; Kerr and Cox, 1988) and runners (Kerr and Vlaswinkel, 1993) has shown that more successful performers have a lower discrepancy between felt and preferred levels of arousal. These may be seen as an ideal performance state similar to Hanin's (1980) ZOF. Contrary to expectations the slalomists in this study did not perform their best when in the ZOF. In fact the opposite was true: the better performances, on the whole, were recorded when they were outside the Zone.

It is also worth noting in **Table 6** that the greatest number of observations were placed in the 'Below' Zone cell. This would not negate the ZOF as a valuable concept. In fact coaches and performers do speak of being 'ready' and 'in the zone'. The problem, as shown by this study, lies in finding a way of measuring what this zone is. This problem is likely to be exacerbated with elite performers. It may seem that they would be operating within a very narrow ZOF most of the time and that is what makes them special. On the other hand it is more likely that assuming elite performers can better tolerate a wide variety of sub-optimal conditions, their ZOF might be very wide. In fact it might be so wide as to have no effect on the data in this study. However, perhaps research to date has tried to establish another zone which is even narrower and within this ZOF. To find such a zone may be asking too much of the available measuring instruments. It is also likely that, during events lasting for long periods of time, performers could be moving in and out of this zone. It would be expected that the successful performers would stay in the zone for longer or possibly make sure they were in their ZOF during critical phases of the competition. This view-point is related to that taken by Hagtvet and Ren-Min (1992) who maintain that the relationship between anxiety and performance may vary across performance, and is therefore a process construct as opposed to its general conceptualisation as a summary construct.

A number of explanations can be offered as to why the performance levels of world class slalom canoeists do not vary according to their anxiety levels at international competitions. It could be suggested that elite performers simply see competition as a task to be completed. They concentrate on the best way of accomplishing this task and, being highly competent, do not let their anxiety levels affect their performance. Additionally, they have attained this competence having come through lower grade events where the selection process only allows the best to be successful. During this process they may have developed coping strategies that do not allow other factors (as measured by the CSA1-2) to interfere with their performance. This would concur with the findings of Males and Kerr (1996) who reported that irrespective of varying levels of anxiety, feelings of excitement, pride, and relaxation had very little effect on the performance of elite level slalom canoeists.

An alternative explanation is based on the fact that competitive slalom canoeing is a complex task. The constantly changing competition environment, in which it is necessary to be continually alert, may take up all of the performer's processing capacity and not allow for any other thoughts to be brought to the conscious level. Other sports (e.g. pistol shooting) may have low levels of cognitive demands so that only a correspondingly low amount of processing space is required to complete the task. As a consequence there is additional space available to allow distracting thoughts to be processed thereby possibly affecting performance (Landers et al. 1980).

It could also be suggested that these elite canoeists, who were ranked amongst the best in the world, may have found ways of restructuring and possibly re-labelling anxiety symptoms from negative to positive (Kerr, 1990). This may then have the subjects answering the CSAI-2 questionnaire in a positive way, in order that no negative thoughts were nurtured, particularly in the 15 minutes before an international/olympic run.

The results in this study showed that the subjects tend to have relatively low scores on the anxiety scales (**Table 2**). Their mean scores on both the cognitive and somatic scales were 11 (sd.$\pm$1.9) and 15 (sd.$\pm$ 2.2), respectively. However, Jones et al. (1994) have shown that elite performers often view the elevated intensity of their anxiety as being facilitative. A longitudinal, in-depth investigation of intensity and direction of the dimensions of anxiety of basketball players by Swain (1992) showed that a player could have the same CSAI-2 intensity score on the somatic component, but that their affective experience could be positive on one occasion and negative on another. So, some paradoxes are apparent when trying to unravel the complexities of the effect of intensity and direction of anxiety on performance among elite athletes.

What determines good performance at elite level in sports such as slalom canoeing, which is a combination of physical, mental and highly intricate motor skills, is extremely complex. As Jones (1995) has aptly pointed out, anxiety research to date has had limited success in predicting a substantial amount of performance variation. He also draws attention to the idea that it is likely to be over-optimistic to expect that performance will be predicted by a measure of anxiety acquired perhaps thirty minutes before competition. Apter (1982) concurs with this statement by pointing out how quickly a response/ mood can change. This clearly begs a number of questions about the validity of measuring instruments used with elite performers. Are instruments sensitive enough to measure small changes or are they even measuring those factors that could form part of a deterministic model?

On a more personal basis, observations in the author's role as a coach, for 14 years, clearly showed that these slalom canoeists were often very worried about a forthcoming competition. It was often expressed verbally, or by sheer frustration and loss of form in practice sessions beforehand. Personal relationships with fellow team members and support staff often showed tension that was not normally present. Denying anything was maybe wrong (at least in the written form) could be a coping strategy adopted to maintain confidence in the face of an imminent competition. Furthermore as a coach it was necessary to take account of each individual athlete's state of mind and if necessary use appropriate psychological interventions.

Retrospectively, competitors may review their psychological feelings more objectively and admit there were problems in the lead-up to competition. This could be one of the advantages of using post-event recall (Imlay et al. 1995; Harger and Raglin, 1994) which may in fact provide a more accurate measure of a subject's true anxiety state. Subjective assessment of psychological states may provide a more suitable way of predicting performance even though such assessments can be difficult to quantify. (Gould et al. 1993; Raglin and Morgan, 1988). It is worth noting that these competitors were very accurate at pre-judging their technical performances. On this premise future work related to emotions and performance using a mixture of qualitative and quantitative methodologies looks promising (Males and Kerr, 1996).

The findings from the present study have implications for future research. From a theoretical perspective, it is suggested research should continue to focus upon the particular nature of the interactive effects of anxiety sub- components with elite performers. This suggestion is based on the findings of this study, in the light of the apparent differences in outcome between the present study and the previous exploratory research (Hardy and Parfitt 1991; Hardy, 1996). Qualitative post event re-call linked to video footage of events may provide a method of re-establishing the on-going process of performance. With respect to an applied perspective, it is important to recognise that elite performers do not necessarily experience anxiety immediately before competition. Therefore indiscriminate use of techniques that may calm or psyche-up an individual are inappropriate. If an individual is to be successful it might be worthwhile considering a wider range of emotions than just anxiety (Apter, 1982; Hardy et al. 1996). Perhaps this is the meeting point for theoretical and applied research to take this concept further in the interests of the elite performer.

Even taking account of the limitations of this study in terms of the numbers of subjects and the use of pencil and paper tests, it still has some strengths. The analysis incorporated standardisation procedures, and the study was carried out over a period of two international seasons. The subjects were also world class performers and the research was completed in the field as immediately before competition (15 minutes) as realistically possible. However, not withstanding the face value of these conclusions the reservations made in respect of the sampling size suggest that the results require replication and be treated with caution when applied in the context of external validity.

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CHAPTER 5

Case studies of elite slalom canoeists preparing psychologically for competition

5.1 Introduction

It has always been the ultimate aim for all those involved in elite level performance, that is athlete, coach and psychologist, to produce the best performance at the most important competition from each individual. This is complicated when all concerned know that a particular athlete has the attributes to produce the best performance in the competition but are uncertain whether that potential performance will be produced. This leads to a great deal of introspection, evaluation and speculation. The complexities of performance at elite level are very apparent, but ways of unravelling them are not so apparent.

Analysis of how the elite perform skills has been conducted for some time, (Russell and Salmela, 1992; Abernethy, 1994; Abernethy et al. 1994; Thomas and Thomas, 1994). The efficacy of this analysis is based on the view that elite athletes must be performing specific physical and mental skills in a certain way that is successful. In order for them to be elite they must have the appropriate mental and physiological components. Starting from this premise it should be possible to study how elite athletes, those that are highly successful and those who are not so successful, equip themselves to prepare for competition. It is already known that stress can cause anxiety and this is felt by performers. It is also likely that they have developed ways of dealing with mental components when competing at this level.

However, it is also obvious, particularly in canoe slalom, that some competitors are consistently more successful than others. Examination of this phenomenon may at least lead to an insight into how athletes prepare for competition, how they feel during competition, and how they evaluate their mental state in relation to that and forthcoming competitions.

The impetus for this research lies in the need to establish how particular individuals prepare, perform and evaluate that performance. The components that constitute that preparation may appear to be simple and could easily be listed. However what may not be so obvious are the interactions that are taking place between the components and also between the athlete and fellow athletes and, of course, the coach.

Furthermore, research using the Competitive State Anxiety Inventory (CSAI-2) Martens et al. (1990) and relating this to performance of elite level slalom canoeists showed no significant trends (Mantle et al. 1997). Additional analysis also showed that there was no evidence to support Hanin's (1980) Zone of Optimal Functioning (ZOF) hypothesis. Yet intuitively the ZOF is appealing to both coaches and athletes as there is often talk of being "in the Zone".

What interested the author, who had coached all the individuals examined in the above research for a considerable number of years, was that the CSAI-2 indicated high confidence scores and relatively low scores on the cognitive and somatic anxiety scales. Observation of their behaviour and listening to their worries and concerns both in training and competition indicated that anxiety was present. It was therefore postulated that the CSAI-2 was not encapsulating the true feelings of these elite slalomists.

So are the instruments that are being used to measure, for example, anxiety and then relating this to performance too insensitive at an elite level to pick out discriminatory factors? Alternatively are elite slalom canoeists denying any problems when going into a major competition as a form of coping (since to admit problems may switch the focus from the task in hand to emotive thoughts).

The purpose of this study was to:

a) assess the individual's behaviour in relation to competition

b) apply appropriate interventions

c) evaluate the effectiveness, and thereby

d) gain a greater understanding of the individual in ecologically valid settings, in preparing for major competitions including an Olympic Games.

5.2 Methodology

5.2.1 Rationale

A case study methodology has been chosen, although note is taken of Stake's (1994) remarks when he points out that case study is not a methodological choice but a choice of object to be studied and, as a form of research, it is defined by an interest in individual cases.

It is also important to establish that the work constitutes an intrinsic case study (Denzin and Lincoln, 1994), an attempt to understand a particular case. This may extend to collective case study where common characteristics may manifest themselves. The methodology, by using a qualitative approach, is also adhering to the notion of letting the case tell its own story (Carter, 1993; Coles, 1989). This is seen to be important in this research as it is attempting to understand what is significant about the cases within their own world and to give a greater insight into the issues, contexts and interpretations.

It is appreciated that qualitative research using case study approaches is not without risk. (Herriott and Firestone, 1983; Lofland and Lofland, 1984; Miles and Humberman, 1984). Even taking into account the multiple sources of evidence that can form a chain of explanations a certain amount of inference can take place (Yin, 1994). The consideration of rival explanations would help to counteract this.

The author in this research is deemed to be a participant observer, being both the coach and sports psychologist to the participant canoeists. The advantages and privileges of this position allow the research to take on a grounded theory approach where there is continual interplay between analysis and data collection and thereby constant comparative analysis (Glasser and Strauss, 1967). At the same time the author has been aware as a participant observer that he is open to changing the subjects because of the intensive relationship he has with them, and also of the possibility of changing himself (Clandimin and Connelly, 1994). It is also appreciated that case-study is not exhaustive in its description and analysis of the person and situations, but rather it is selective in that it chooses to concentrate on certain issues or underplay others.

This study has as its working principle Bromley's (1986) view that a psychological case-study is an account of how and why an individual behaved as they did in a given situation. There has deliberately been no attempt to use case-study methodologies that incorporate content analysis and levels of comparison.

5.2.2 Protocols Adopted

The study adopted a non-experimental protocol which was based on single-subject design (Hersen and Barlow, 1976; Kazdin, 1982; Bryan, 1987). However, instead of adopting the traditional A-B-A-B design where it is usual to measure quantitatively the various stages from baseline through intervention to the final evaluation of the effectiveness, qualitative methodology has largely been used, although there are combinations of quantitative and quantitative methods as described by Steckler et al (1992) (see section on procedure).

Note has been taken of five basic rules for the preparation of psychological case-study as suggested by Bromley (1986). Included in these rules are Truth, Clear Aims and Objectives, Prolonged Enquiry, Ecological Context. These are similar to the definition of the concept of "trustworthiness" as proposed by Lincoln and Guba (1985). It was felt that the idiographic approach would allow examination of changes within individuals that might lead to clearer understanding of whether nomothetic aspects apply to these individual subjects (Dunn, 1994).

However, it should be noted that the purpose was not to seek and analyse between-subject variations (Smith, 1989). Ecological validity was seen as a prime focus in the study because of the methodology adopted and the unique opportunity to study elite performers over a prolonged period of time in their training, travelling, living and competitive environments. The author immersed himself in this environment feeling that this method matched the particular question of interest in this research (Hardy et al. 1996a).

5.2.3 Assessment Procedures

Three assessment procedures were adopted:

A). Nelson and Hardy's (1990) Sports - Related Psychological Skills Questionnaire (SPSQ) was used to assess the current mental skill level of the subjects. The sub - scales measured are imaginal skill, mental preparation, self-efficacy, cognitive anxiety, concentration skill, relaxation skill and motivation. The scale consists of 56 items with 8 items in each of the 7 sub - scales. Responses are scored on a Likert Scale ranging from 6 (strongly agree) to 1 (strongly disagree). It is reported that Cronbach's alpha for the selected items in each of the seven categories exceeded 0.78 (Nelson and Hardy, 1990).

B). The Performance Profile (Butler, 1989), which has its origins in personal construct theory, (Kelly, 1955) was used to identify the individuals' unique way of making sense of the world. The method involves asking the athlete to identify those qualities he believes to be most important for elite performance in his sport. The athlete then rates the relative importance of each quality, and then assesses his own current status with respect to each of the qualities. The scoring used was either 1 (least) to 10 (most) or 1 to 100%, depending on which the athlete found easiest to use for the ratings.

C). An Interview which had a structure based on gaining descriptions of current medical symptoms (Macleod, 1973) and adapted for use with psychological emotional symptoms (Stern and Drummond, 1991), was used as a prompt and to probe for more details. The questions that formed the structure if, for example, the canoe slalomist presented with a history of no confidence would be:-

a) main site - a full description of what the athlete means by no confidence.

b) radiation - a full description of the thoughts, fears, and emotions of the athlete at the time of the above symptoms.

c) character - a full description of every symptom or change which occurs from the onset to termination of the episode.

d) severity - the severity of each of the above physical and emotional symptoms.

e) duration - the duration of each of the above physical and emotional symptoms.

f) frequency and periodicity - how often do these symptoms occur and do they vary in severity?

g) special times of occurrence - what time of day, when, where and with whom the symptoms occur.

h) aggravating factors - does anything make the symptoms worse or more likely to occur?

i) relieving factors - does anything make the symptoms better or less likely to occur?

j) associated phenomena - any other symptoms which have occurred?

5.3 Subject 1

5.3.1 Background

Subject 1, was a married full-time slalom canoeist who had been involved in the sport for fifteen years and was extremely successful at international competitions. He had completed a University education specialising in the exercise sciences, and had developed highly sophisticated personal training in both the conditioning and technical aspects of canoeing. He possessed the ability to devise new ways to maintain his motivation and was able to design and develop products for canoeing along with marketing strategies. Financially he was secure and could therefore choose where and when to train.

He was regarded as the most successful competitor of all time in his sport. He was and still is highly respected, but also has a reputation for not allowing anything to prevent him reaching his goals. In preparation for his Olympic selection and competition Subject 1 approached the author with the suggestion that he needed to revise his mental skill.

5.3.2 Assessment

In the first few sessions the standardised assessments, as previously described were completed. The results from the SPSQ (Table1) showed Subject 1, at the time of the assessment, to have good developments in Self Efficacy and Motivation. Cognitive Anxiety Control was regarded as reasonable. The areas that were seen to be weaker were; Mental Preparation, Concentration, Relaxation, and Imaginal Skills Within Mental Preparation it was noted that Subject 1 rarely set specific weekly goals, and seldom practised ways of relaxing and concentration. It was also noted that he perceived himself to be easily distracted and sometimes talked himself out of doing his best.

Table 1 Scores from the SPSQ for Subject 1

Category	Score (max 48)	Deficit (Max score-subject's score)
Imaginal Skills	36	(-12)
Mental Preparation	34	(-14)
Self-Efficacy	45	(-3)
Cognitive Anxiety Control	40	(-8)
Concentration Skills	35	(-13)
Relaxation Skill	36	(-12)
Motivation	45	(-3)

The performance profile (pp) was composed of ten words and Subject 1 felt a % system of his current status would be most useful. The selected constructs and Subject 1's definitions are given along with the % rating in **Table 2**.

Table 2 Attributes and their definitions that are required to be a world-class slalom canoeist, as devised by Subject 1.

Construct	Subject 1's definition of constructs	Current Rating (100%)
Control	Being able to cope with size of situation and pressures of big race. Control anxiety, thoughts, feelings, emotions, distractions	75%
Confidence	You can do it -self belief. Also confidence on moves to go for it. Positive feelings about self, others, competition and outcome. Quietly ooze confidence.	85%
Focus	Concentration on task. Ability to close out distractions. Selective focus. Sharp focus in race situation. Focus affects timing and judgement, decisions, reaction, control and precision. Sharp focus holds race together.	70%
Relax	Ability to switch off from intensity of effort or situation. Recharge batteries, energise body and mind. Relax and go. Relaxation helps control, focus and confidence. Enjoy.	70%
Image	Ability to visualise race and other situations accurately. See and feel the action. Positive image of outcome	85%
Desire	Deep down you want this. A burning desire for the outcome. You want to win. Enjoy the feeling.	95%
Aggression	Controlled aggression. Attack the moves and go from the gun.	95%
Determination	Keep it together. Cope with everything. Ready for anything. Never say die. Pull hard to the end.	90%
Instinct	The hidden quality. The sum of all the parts. Trust it. Use it. Believe in it. This is the creativity and feeling which sets you apart. The spirit of the river.	no % given
The Winning Feeling	The state of mind which lets performance flow. A passing moment in the lifetime of effort. Work towards it. When you get there identify it. Remember how you arrived there and go back as often as possible.	no % given

The interview had as its focus the performance profile. Subject 1 was able to cite any concerns he had regarding his preparation for international trials and competition. It was apparent that, despite having achieved the highest honours in his sport, he had serious doubts about his ability to control his life in general at the current time. This had been mainly due to the pressure of having to fulfil so many business commitments in designing and marketing canoe products with the added problem that much of this work was to take place in Japan and Southern Europe. Coupled with this was the realisation that his days as a competitor were limited by his age. It was therefore important that he capitalised on his success and promoted his own image in order to give him a paid living in related activities when he retired. This meant there were continual calls on his time, including having to attend functions where he was to make important contacts. He was also in the process of writing a book and establishing himself in television as a commentator.

As a consequence, although he still maintained confidence in his ability as a competitor, he was concerned that he would have problems in maintaining his focus in training and, in particular, in controlling all the factors that he perceived to be vital to give consistency and good results at lesser international events leading to the Olympic Games.

He had real fears about not being selected for the team, and about this consequently destroying his image in the eyes of others. There was continuous reference to symptoms that indicated he was finding it difficult to relax and that distractions were draining his energy. He had feelings related to being disorganised. At times in squad sessions he found he was thinking about other unrelated matters and was less tolerant of minor problems that occurred; these included mistakes made by the coach (the author) or having to alter plans at the last minute, when for example the weather meant the planned session was impossible.

Although he was aware that these problems might arise he found they were worse than he had anticipated and this affected his motivation. Symptoms and onset tended to be worse when he trained with those in the squad who he perceived to be, at times, indecisive and un-cooperative.

He made reference to those factors that had been his main strength in performing in the past and the need to recapture such concepts as Image, Desire and Determination. Particularly strong was the desire to identify and revisit the winning feeling in order to remember how he achieved this state of mind. On enquiring about which factors in particular relieved his anxiety he was very clear. He identified training sessions which either taxed his whole energy system or technical problems that demanded an instant solution which, when found, meant that he was then able to reproduce the required movements consistently.

There was also the continual worry that he may have gone past his best and, despite having won the World Championship four times, there were fears that he would be finishing his career by not making the Olympic Team. He had often won the World Championships by producing an exceptional final run, and he wondered whether he had been living on 'borrowed time' and this had now 'run out'. He had been beaten by a fellow team member at the previous world championships. He was aware from the physiological testing that his overall fitness was not as good as the other members of the squad, even though he trained just as hard and gave 100% effort. Age was against him, but he acknowledged his greatest asset was consistency. At its worst his worries tended to affect his concentration and he would make careless mistakes.

A further problem was highlighted concerning his wife, who was also a World Champion and trained with Subject 1. Her country of origin gave huge accolades to successful women in sport. Subject 1 was aware that he could spend a great deal of his time coaching her and this was likely to lead to her success to the detriment of his own. Although in the past he had been able to shut this off and leave her to her own devices, he now felt duty-bound to help her as she had lived a great deal in his shadow even though she was a Champion in her own right. He felt it might damage their relationship if he maintained his previous strategy of only focusing on his own training and not sharing his expertise with his wife.

5.3.3 Formulation

From a psychological point of view it appeared that Subject 1 was a supreme competitor, who was hanging on, perhaps beyond normal retirement age, to compete in the Olympic Games in 1992. However, Subject 1 had doubts that he would not make the team and was torn between retiring now as World Champion, leaving the lasting image of the greatest competitor in the sport, and going on to enhance his image with the Olympic title. It was obvious that Subject 1 had the ability, knew exactly how to train for conditioning and could bring a vast amount of experience to both the selection events and the Olympics itself. However, one of the main problems, which had not been apparent previously in preparing for competition, was the dichotomy between giving up all other commitments in order to concentrate on his preparation or trying to maintain these commitments in order to enhance his chances of making a living on retirement or perhaps, more importantly, if he didn't make the team.

There were further complications as his perceived image was a critical factor in the mind of Subject 1. This image, in relation to his future, was a delicate issue in terms of its enhancement, and Subject 1's acceptance of his current image or possibly losing his aura.

Anxiety seemed to be the result of these problems and this manifested itself during training sessions. There were examples observed by both Subject 1 and the author of irritability with coaching staff and other members of the squad. It almost seemed as if perfection in everything he did as a paddler was essential to Subject 1 if he was going to succeed and this attitude was projected on to others.

Competitors at this level often strive for this form of perfection, but to do so normally requires the athlete to be highly organised and to be very clear about his goals, particularly in relation to the technical improvements. Here was an individual who had achieved the highest accolade in sport, was still capable of producing the highest levels of performance (in the author's view as his coach) and yet had suddenly met a crisis which was new to him.

Twelve years observation of this athlete had shown that he never faltered, was never indecisive, never had any self-doubt or lost any motivation, was never disorganised and was never in doubt about his priorities. Suddenly a dilemma as to whether to carry on to try to compete in the Olympics or to finish at this point seemed to underlie the problems that manifested themselves in the symptoms described.

It seemed that initially it was important to clarify whether a number of issues, (e.g. external image, problems of future career, and the importance of his wife's success) were perceived or real. Although these were the central areas of concern it was acknowledged that there might be additional hypotheses to be tested as the interventions progressed. With these considerations in mind the intervention programme was drawn up.

5.3.4 Intervention 1

The interventions were divided into phases. Firstly the focus was on clarifying exactly what Subject 1 wished to achieve in his life by using a life planning exercise questionnaire (Pedler et al. 1978). Secondly, a meeting was arranged with Subject 1 and his wife where it was agreed that they would talk through the problems Subject 1 felt he had in trying to achieve personally and at the same time coach his wife. The meeting was conducted using a facilitator (the author) and utilised a Gestalt dialogue in exploring polarities (Syer and Connolly, 1984). Fundamentally this involved Subject 1 exploring the self in relation to the forming and dissolving of meaningful figures of interest against a background of the individuals changing field or world. Particularly important in this instance was the interaction between Subject 1 and his wife, and exactly who he was in relation to her. Exploration of whatever was happening here and now to Subject 1, without denying the past, and then clarifying the contradictory polarities that might exist (e.g. kindness and cruelty) in relation to coaching his wife were regarded as vital if he was to continue to develop as an athlete. The meeting also explored Subject 1's self-image and self-esteem. This exposed the choices that were available to him (given his current feelings) if he was to respond flexibly and variously to a broad spectrum of different situations and people in preparing himself for the future.

5.3.5 Intervention 2

A further meeting was conducted one week later, after Subject 1 had reflected on the issues raised in the first meeting, particularly in relation to his image and the life-planning exercise. It was agreed that having clarified what he wanted to achieve during the next 18 months of his life he now needed to do four things:

a) identify commitments and establish which of these were essential to his career development, prioritise these and drop the rest.

b) co-operate with the rest of the squad and among them identify advanced techniques that are required at Olympic level and target these in training sessions.

c) start goal-setting.

d) through the coach, organise a technical session once a week, thus giving subject 1 control of that particular session.

5.3.6 Review of Interventions 1 and 2

The interventions were reviewed formally six weeks later, although informal observation and critical incidents were particularly noted by the author in his duties as coach. The main points to come from the review were that Subject 1 was motivated, clear about his role in coaching his wife (she was perfectly happy to do her own training, but once a week they trained together and planned to spend a number of weeks away training together in Australia), had decided on his career priorities and already cancelled unnecessary engagements, (e.g. presenting the prizes at his former school).

The technical targets had given a clear focus to him and the rest of the squad, which helped relieve him of anxiety and gave him some empowerment. It also meant that some of the problems the coach may have encountered in not being perfect could be switched and attributed to Subject 1, with the confidence that he had the knowledge and ability to make improvements. This in itself created a better atmosphere. Individual process goals which included areas such as organising time, travel and business commitments, technical and fitness targets, had increased motivation and the exploration of what external image meant to Subject 1. He had also, to some extent, de-mystified the idea that if he did not achieve an Olympic medal Subject 1would be seen as anything but the best competitor of his time (and of all time up to then). In addition the review highlighted the need for Subject 1 to re-set goals on a long-term basis and to revisit some areas of mental training which he had used very successfully in the past.

5.3.7 Intervention 3

Subject 1 had previously used a number of psychological techniques to help him prepare for International events and now felt he needed to re-learn these techniques. As part of his general physical stretching, he wished to incorporate progressive muscular relaxation (Jacobson, 1938; Rotella, 1985; Ost, 1988). Centering, for on-the-spot instantaneous calming (Nideffer, 1981), was used. For maintaining concentration, the slalom course was broken down into smaller linked sections, each one requiring a particular emphasis, e.g. there are some parts of the slalom course which require an optimum speed - a faster speed saves time but the risk of penalties increases disproportionately. Subject 1 incorporated these mental training techniques into his monthly goals during the training and preparation phases.

There was one other relieving factor that may have proved significant in alleviating Subject 1's anxiety. He had asked the Great Britain slalom canoeing selection committee for pre-selection based on his past performances. He was granted this and he continued his preparation.

5.3.8 Further developments

Subject 1 continued to make good progress in all his preparation, the physical and technical preparation proceeding particularly well. His mental preparation was, as he put it, 'just right for now'. Part of the Olympic preparation was for the whole squad to go to Australia and New Zealand to train and compete in warm conditions. This was a four week tour and no coach was available for this period, so the squad was unaccompanied (not an unusual occurrence). The squad having departed, the general membership of the British Canoe Union (Governing Body of the Sport) called an emergency general meeting to overturn the pre-selection decisions. They succeeded in doing this. The information was conveyed by the author to the squad in Australia. This apparently caused some serious conflict in the squad as a number of the members (those not pre-selected) were seen as the instigators (indirectly) calling for the special meeting.

Although a further emergency meeting had been planned by the Great Britain selection committee to offer an alternative selection policy, there was still turmoil in Australia. Subject 1 communicated directly to Britain on a daily basis, expressing his anger and sense of betrayal and showing signs of anxiety. He had also decided to train more on his own and not to share his knowledge with the rest of the squad. Additionally he made it quite clear that that he had no intention of being part of the group when they returned to the UK. At the time there was very little a coach could do at such distance other than stay absolutely neutral (he did not attend any of the emergency meetings), and just encourage each individual to carry on with his training.

5.3.9 Intervention 4

For Subject 1 this was part of the 'team re-building'of the elite squad after their return from the Australian Tour. It consisted of re-establishing the dynamics of this group through a series of team meetings. It was during these sessions through a process of honesty, openness, descriptive feedback, and awareness, that it was possible to re-establish trust among the squad members (Syer and Connolly, 1996).

There was also some individual discussion with Subject 1, now concerned with having to deal with a selection event. As a result of the discussions Subject 1 reviewed his training diaries which recorded his feelings when he performed successfully and acted as positive self- affirmations. He also moved his goal-setting more towards performance outcomes during training sessions.

5.3.10 Outcome

Subject 1 really made considerable progress in understanding his own problems, especially with regard to his relationships with significant others, with his past performance, and how to deal with organising his training and business commitments. He was also able to clarify his own and his wife's perceptions of how they saw their personal relationship and training integrating. The previous mental training techniques were relearned and applied in training and competition. He dealt with being part of a squad that was divided by the selection issues and became one of its most stoic members.

Subject 1's performance at international events was not as good as in previous years, although he was rarely out of the top ten placings and won the selection event overall to go forward to the Olympic Games as the No. 1 paddler from Great Britain. At the Olympics he felt he performed very well, missing a medal by 33/100ths of a second.

(Interestingly he carried on his paddling and both he and his wife won honours at the highest levels of competition).

5.3.11 Discussion

This case illustrates an eclectic approach to inventions, and thereby affords many advantages. It does not close off any possible problem areas, whether these be the influence of significant others, self-conflict or faulty learning patterns. The case also shows the usefulness of drawing on a variety of assessment and intervention techniques to facilitate change in the cognitive, emotional and behavioural domains rather than relying on one particular area as a prime focus of the interventions. Furthermore it does indicate the subtlety of anxiety symptoms which may explain the inability of the CSAI-2 to predict a large proportion of the variance in performance.

5.4 Subject 2

5.4.1 Background

Subject 2 was single and, although a full time student, was able to devote a great deal of his time to training during the period being examined as he had completed most of his final year project. He was a highly talented paddler, who had produced a number of very good international results. His approach to preparation was somewhat haphazard and his general attitude to life was very similar, though he always managed to succeed in whatever enterprise he embarked upon. Subject 2 tended to depend upon others to organise him. He was relatively new to the senior squad. He had to operate on an extremely tight budget as he had no sponsorship and did not qualify, on his results, for an elite grant.

Subject 2 had never involved himself in any mental training previously. He was an outstanding competitor on the day, showing few signs of anxiety, and loving racing. However, during the last 18 months (since being in the senior squad) his results had not been as good as had been predicted by the coach.

5.4.2 Assessment

The SPSQ (Table3) gave the following results for Subject 2:

He was highly motivated, very relaxed, had low Cognitive Anxiety, was highly confident (Self-Efficacy,) and good on Concentration. His lower scores tended to reflect how he approached competition with low Imaginational Skills and a similar rating for Mental Preparation. Significant factors that emerged from these last two categories indicated that Subject 2 rarely used any mental rehearsal, did not like to imagine skills before practising them, did not practise relaxing and did not set goals or analyse his performance.

Table 3 Scores from the SPSQ for Subject 2

Category	Score (max 48)	Deficit (Max score-subject's score)
Imaginal Skills	34	(-14)
Mental Preparation	34	(-14)
Self-Efficacy	48	(0)
Cognitive Anxiety Control	43	(-5)
Concentration Skills	43	(-5)
Relaxation Skill	46	(-2)
Motivation	46	(-2)

The Performance Profile elicited the following responses as shown in **Table 4**:

Table 4 Performance profile attributes definitions and ratings for Subject 2.

Construct	Subject 2's definition of constructs	Current rating (10)
Concentration	Ability to concentrate on the situation in hand	7
Relaxed	Relaxed and controlled in unnatural and sometimes annoying situations	8
Determination	Determined never to quit, keep going when things are down	9
Arrogance	Arrogance, but kept to yourself	8
Competitive	Positively stimulated by competitive situations	8
Motivated	Motivated when defeated	9
Motivated	Motivated when winning	8
Respect	Respect other competitors, until competing against them, but again kept to yourself	7
Self - Importance	Self-importance, but kept to yourself in race situations	10

The interview concentrated on the performance profile and SPSQ. Initially it was pointed out by Subject 2 that he had no experience of mental preparation. He felt he was a good competitor, loved racing, rarely became nervous and did not have any problems. However, he did point out that he would like to be a little better organised and thought that his concentration could be improved. This was surprising as his score on the SPSQ was reasonably high, although it did differ relatively from the performance profile score.

On exploring these matters further it was revealed that Subject 2 felt he had skills, but there were times when he was indecisive about which ones to use to complete a certain gate sequence. He also found his concentration lacking during certain races. There was no particular pattern to these incidents, nor were there any specific factors that seem to relieve them. However he had noticed that he was more aware of his lack of general improvement since being in the senior squad. Subject 2 was also aware that another member of the squad was scrutinising his preparation, was extremely helpful in his planning, but was also very critical and, as Subject 2 saw it, very judgemental.

5.4.3 Formulation

After the first interview a number of issues were identified:

a) the enjoyment and love Subject 2 had for competition before joining the squad.

b) that some indecision was present during difficult technical moves on a slalom course

c) there was a lack of mental and general preparation for international competition

d) that Subject 2 had an awareness of lack of progression in his performance

e) that there were indications that a member of the group was helpful, but also highly critical of his preparation.

None of these problems on first appearance seemed to be particularly difficult to solve if Subject 2 wished to avail himself of an intervention programme. In discussing this Subject 2 appeared to like the idea of a programme and was prepared to experiment with anything that would move him off his plateau in performance. He admitted to feeling a little helpless about it all.

5.4.4 Intervention 1

(A) Dealing with indecisions

a) Subject 2 was asked to record, by drawing diagrams of slalom courses, situations where he had been indecisive. Alternative manoeuvres were registered on this sheet, alongside the decision that was actually taken. Additionally he recorded his penalties and was asked to recall his feelings during the inspection period (when competitors are allowed to inspect the course from the river bank), and how he arrived at each decision.

b) He was also asked to repeat this exercise during the next four weeks during the training sessions that involved simulated competitions.

(B) Dealing with incidents critical to him in the senior squad

a) Subject 2 was asked to record any critical incidents during his interactions with other squad members at training sessions or social occasions. Critical incidents were, by his definition, situations where he felt uneasy, or where he was not enjoying training because of the dynamics felt by him within the squad.

b) As Subject 2 had indicated he was having a problem with another member of the squad (as yet unidentified) who was helpful yet critical, he was asked to reflect on this relationship with the following points in mind:

does his helpfulness outweigh his criticisms?

how do you feel when you receive the criticisms?

do you feel there is a conflict regarding the perceptions you may both have in reaction to this help and criticism?

These interventions were seen as a starting point for making an impact on the issues identified from the assessment.

5.4.5 Outcome of the First Intervention

Subject 2 retraced his technical indecisions at international and domestic events and these were collated as shown in **Figure 1**

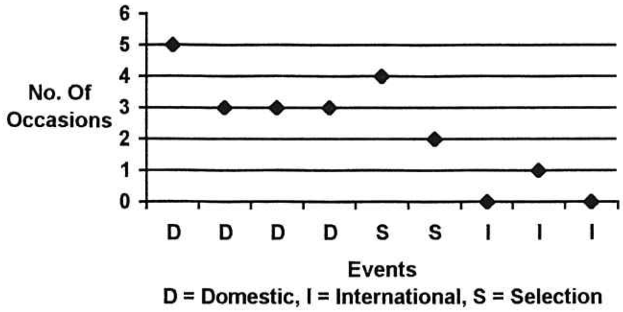

Figure 1 Subject 2's indecisions during slalom competitions

The recording of similar data during senior squad training is shown in **Figure 2.**

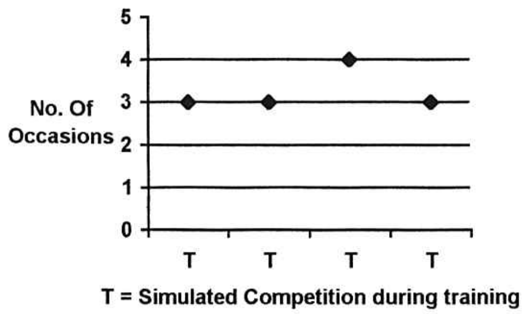

Figure 2 Indecisions by Subject 2 during simulated slalom competition

What is evident on examining **Figures 1** and **2** is the contrast between domestic events and simulated competition and full internationals. On exploring this finding, Subject 2 perceived that it was a reflection on the help he received from the coaches. At internationals they were always at hand, whereas at domestic events they tended to let the competitors 'get on with it'. This was particularly the case in selection events where as Subject 2 put it 'every man for himself - there are no tips from your fellow competitors as they are trying to beat you not help you'.

Subject 2 had also calculated that every course had about six technical moves. The selection events tended to be more difficult than international events. On examining how Subject 2 came to a decision, this was not always clear. Sometimes he was able to gather enough information by observing others to help him make a decision. However, quite surprisingly for such a good competitor, he would make a decision during the actual competition run and manoeuvre the boat onto the most efficient route through the gates at the time. At such a level of competition this would normally be deemed to be a disaster and reduce chances of success dramatically. (Paradoxically in many ways it did show extreme ability and talent.)

The feelings these last-minute indecisions evoked tended to be centred around inadequacy, but at the same time kept him in a relaxed state. He felt that he would enjoy his sport more without all this extra planning and preparation. It also meant he ended up in situations that seemed disastrous to the spectators, but often he recovered to great applause and this gave him a great buzz.

Evaluating the second parts (a) and (b) of the intervention produced a clearer picture than had been indicated from the initial formulation. In fact the two parts were linked. Subject 2 revealed that the reason he felt uneasy in the squad was partly because the other members were highly organised, very committed and very serious. Also the sessions conducted by the coach were highly competitive. In order for him to make any impression in this group he would have to conform to this approach (which he did not like doing). The particular member of the group with whom he was having a conflict between help and criticism was now revealed. This person was much more experienced and, in Subject 2's view, trying to do the best for the both of them. He also felt this person represented his father who was also keen for his success. Subject 2 had not followed the intervention recommendation to record incidents and feelings or to make any evaluations of this Other Person's behaviour. Instead he just wished to talk about the problem and try to clarify his thoughts and feelings.

Using Macleod's (1973) outline to give some structure to the interview, the main factors that presented themselves were:

Subject 2 revealed that his self-confidence had always been low as he felt that the only reason he was good at paddling had been the result of this Other Person's input. He felt that he had also only been the 'little boy' to the really 'good guys'. His father had designed his training programmes, structured competition strategies when he was available, and generally monitored what went on. He didn't feel a person in his own right and had become very fed up with the situation.

At times he was irritable and uncooperative with the Other Person, resenting his competence (this had been observed by the coach). The Other Person then reacted and so did his father. So now Subject 2 felt he was fighting himself and others. He indicated that he had guilt feelings as he felt he should really be grateful. He could not broach the subject with either of them. He asked the author if he would act as a go-between. The situation for Subject 2 proved to be quite serious. Both he and the Other Person had moved to Nottingham to train full time and at one time shared the same house.

5.4.6 Intervention 2

With the approval of Subject 2, the Other Person was approached and the apparent problem was outlined. It was found that much of what Subject 2 had outlined was true but seen from a different perspective.

According to the cognitive model (Beck et al. 1979) assumptions, inappropriate beliefs and illogical thinking errors play a primary part in maintaining problems in relationships with families in particular. It is also interesting to note that certain family therapists (Lederer and Jackson, 1968; Treacher, 1985) regard interventions with individuals as unlikely to have a lasting effect unless the whole family is involved in the intervention.

On this basis it was decided to ask Subject 2 and the Other Person to keep a diary of critical incidents which described emotions and automatic thoughts (Beck et al. 1979) for 2 weeks. (It was decided, on advice from Subject 2, not to involve Subject 2's father at this stage.) Typical extracts are shown in Table 5.

Table 5: Typical diary extracts from Subject 2 and the Other Person with regard to situations, emotions evoked and automatic thought patterns.

Day/time	Situation What were you doing or thinking about?	Emotion What did you feel? How bad? (0-100)	Automatic thoughts What exactly were your thoughts?
Subject 2 Wednesday 8.00am	Other Person training with two others of Team	Despair (45) Anger (80)	They don't like me. I am not good enough. They regard me as the "little" boy
Wednesday 2.00pm	Saw other going through Test Results from BOMC	Guilt (60) Anger (80)	He is so organised I should model him He has stopped me developing physiology knowledge
Other Person Wednesday 8.00am	Training with two of Team. Sees Other Person	Hurt (45)	Why doesn't he take notice of my advice and train with us?
Wednesday 2.00pm	Doing BOMC Test Results	Annoyed (85)	He doesn't care about getting the peaking correct

It was difficult for the coach to make it clear, even though the evidence appeared robust, that the way forward was to plan more carefully, rehearse the moves beforehand and to be certain what techniques were to be used at any given time in the competition.

To progress still further it was decided that for the next three simulated competitions Subject 2 should design the course and give a rationale for five technical moves that it was to contain. Then he was to paddle the entire competition without seeing the rest of the squad perform. Only split times were to be available to him.

5.4.7 What happened

Firstly, Subject 2 was visibly happier in the squad, felt he was communicating his feelings better with the Other Person and vice-versa. There was open appreciation of each other's qualities and they appeared to be working better as a pair. They had made a pact not to discuss their personal canoeing matters when they met socially, and this helped.

The responsibility for designing the courses also had a positive effect. Subject 2 gave a great deal of thought to creating certain technical options and also on seeing split times was surprised how often he had chosen the right option. He also acknowledged how his pre-planning had been helpful in producing performances that were better overall. This began to excite him as he felt he was making progress. It was hoped that this would give him the buzz that he had enjoyed from his previously more adventurous approach.

5.4.8 Intervention 3

It was suggested that he made his own decisions regarding moves as much as possible, taking account of all the factors in making this decision. To enhance the possibility of performing these moves to perfection he was encouraged to learn some concentration techniques and apply these. Videotapes were used (Curtis, 1988; Jacobs, 1988; Botterill, 1988) and Subject 2 was encouraged to reinforce his planned strategies by speaking into a dictaphone when inspecting gate sequences from the bank.

5.4.9 Review of Intervention 3 regarding Concentration

This review took place by interview after 6 weeks. Subject 2 felt that his overall planning was still good, but that the concentration techniques were not helpful. So although he understood the reasons for the techniques they caused him to 'over analyse and cause me distraction, which breaks my natural rhythm. It has broken my preparation down into segments that are too small - separation like this doesn't help me.' He wished to continue practising decision making which felt very good and gave him confidence, but didn't want to be involved in any other training at this point. Evaluation of his relationship with the rest of the squad was good, and it was tolerable with the Other Person. However, he started to raise some issues about the 'relationship with himself'.

He had competed in some internationals in Australia with reasonable results. His CSAI-2 scores, whatever his performance results, always showed high confidence levels with little anxiety (Mantle et al. 1997, Chap. 4). Yet he admitted a few days before the races he was starting to feel anxious, not about the race, but about himself as a person. Further enquiry revealed that he still felt his over-attachment to the Other Person and continual comparison with the rest of the squad. This gave rise to lowering his self-image and self-esteem when he performed below par and to surprise when he did well. So it evolved that he still felt like the little boy, was trying to improve, but was surprised when he did well to the point of disbelief. Were his better performances deserved? Had he really produced or were his results achieved through other people's efforts?

5.4.10 Second Formulation

An elite performer, who does not conform to the squad's norms, can be described by the rest of the group and coach as 'difficult'. However, the 'difficult' individual does not necessarily see it that way and his resultant behaviour is seen to be resistant and unwilling to accept influence or help (Nevis, 1987). Experience had shown the author as coach that within this elite group resistance rarely occurs between equals. Subject 2 did not see himself as an equal, and this view of himself probably needed changing if he were to be fully integrated and to contribute to the squad and prevent any perceived barriers from inhibiting his growth as a performer (Syer, 1986). So although the interventions up to this time had contained strategies for improving technical aspects of his canoeing performance, the underlying factors of integration, dependency on the Other Person, and the perceived ways in which he thought he was viewed by other squad members (resulting in certain behaviours by him) still underpinned his problems.

5.4.11 Intervention 4

The Olympic Selection was relatively imminent and this was taking place on the Olympic

Site in Spain. It seemed imperative that Subject 2 was confident and had a generally good self-esteem, along with positive and realistic expectations about his preparation for the selection events.

It was felt that Subject 2 needed to discuss the issues further to give some clarity to both functional and dysfunctional thoughts, emotions and behaviours (Trower et al. 1988). This was done within a Gestalt consultation model (Ferrucci, 1990; Clarkson, 1992). The aim of the Gestalt model is to use initial questioning in order for the subject to discover, explore and experience his own shape, pattern and wholeness. Analysis may be part of the process, but the aim of Gestalt is the integration of all the disparate parts. The model has as its long-term aim to allow the subject to become totally what he already is, and what potentially he can become. The athlete could then possibly understand that this fullness of experience could be available in the course of his canoeing career and in the experience of a single moment. The questioning techniques used specifically 'disidentification' (i.e. Subject 2 only identifying with one aspect of himself to the exclusion of others - thus possibly blocking out his ability to respond to situations in creative ways) and awareness (helping Subject 2 to avoid evaluation and labelling but instead to accept that how he thinks and feels is alright; thus reinforcing the functional rather than dysfunctional behaviour). Typical questions that allow the subject to arrive at the states described are given in note form below for clarification :-

Which environments feel most comfortable to you?

What in particular do you notice about these environments?

What feelings are associated with places? How does this change when you feel uncomfortable?

How do you want to feel? What helps or prevents this happening?

Are feelings fact for you? How would you feel about your feelings being enacted here and elsewhere?

How would you see these feelings being part of the choices you may have available?

Invite yourself to have a reality check about how others see you – start with me (author)

A further examination of the accuracy of perceptions is made, along with an assessment to identify possible projections that are being made onto significant others. The limits that these projections can create in self-development are explored in order to identify potential opportunities which could bring about change within the subject. For further information the reader is referred to Mackewm (1997)

5.4.12 Outcome

In terms of his international performance, Subject 2 was only selected for one race in which he came 8th. At the Olympic selection races he was 9th and 3rd which on the selection points criteria gave him 6th overall, with only the first three paddlers selected. He did well at the domestic events, giving him a final classification for the season of 6th - which in his event in Britain (the best nation in the world) was very good.

5.4.13 Discussion

Measuring the success of the intervention programme as a whole would show it to be only partially successful. Subject 2's preparation and decision making improved. His concentration did not, but it may be speculated that it probably was not a real problem. In terms of the way he integrated within the squad, observation of Subject 2 and other members of the group seen at close quarters over a period of twelve months indicated he was at ease. He himself (which was where the real problem lay) felt happier and acknowledged he was making contributions. He felt more of an equal and accepted that technically he was learning quickly. He also recognised he could perform certain moves better than others for whom he had great respect. Whether this development and growth would have taken place anyway through time is conjecture.

The relationship with the Other Person was much improved. They both recognised the others needs and there was a degree of mutual respect. The Other Person did make the Olympic Team, which was expected, but perhaps in the end he had to concentrate on his own preparation and this naturally eased the problem by giving less time to Subject 2.

5.5 Subject 3

5.5.1 Background

Subject 3 was 25 years of age, single, and had a part-time job. He had moved to Nottingham to take advantage of the facilities and availability of training with the elite group. He had an excellent international record as a junior having won the World Championships. At senior level he was making reasonable progress. His results in the previous two years had been inconsistent, but had seen him produce a win, a 3rd position and 5th position in fifteen races.

He was an excellent all-round athlete, being a very good runner and skier. Subject 3 organised his training and preparation with military precision. He was able to fit in his work duties (his only source of finance) with training and he was up-to-date on any research pertaining to conditioning. Interestingly he felt there was nothing particularly complicated in Sports Psychology, and most of this could be gleaned from a book. He questioned the value of any questionnaires in both assessment and monitoring progress. It should be noted he had the same scepticism about the physiological testing. However, he was willing to undertake any form of preparation if he felt it could improve his performance, provided he could pull out at any stage.

5.5.2 Assessment

As Subject 3 had pointed out that he thought questionnaires were of limited value, it was decided to use an informal interview as the first stage of assessment. It was also decided, because the athlete was so well known to the author, to use a holistic Gestalt approach, as described earlier, (Clarkson, 1992). On this basis Subject 3 was encouraged to explore what he felt about his paddling career so far, and how he saw the future. There was also encouragement for Subject 3 to explore any problems he may have had in performing in international competition. This was followed by some careful questioning (typically these were as described previously) to allow Subject 3 to gain greater awareness of the issues surrounding his description of any problems.

It evolved that he saw himself as a failure and probably felt that when in his role as senior athlete within the squad, it gave him status and empowerment to compensate for this failure. However, it then meant that he had to perform at higher standards to maintain this status. Further exploration revealed he had a perception of failure which was based on his own very high standards. By setting such high standards, he became disheartened very easily when they did not work out. Often his goals were too ambitious, but as he remarked 'If the goals are not difficult they don't extend an elite athlete'; such goals were therefore seen by Subject 3 as worthless.

This then affected his confidence, particularly on the start line. If his training and performances immediately before a race were poor, then he went to the start line worried. This was made worse in competitive training situations or in situations where he found himself compared to Subject 1. He also felt that other paddlers often judged themselves and how they were performing by comparing themselves to Subject 3, or by just watching him to see if he was on form. Subject 3 found this difficult to cope with when he was being judged as 'on parade'.

Subject 3 knew he had the skill, yet still did not believe in his own ability. During a competition an early mistake was dwelt upon during the remainder of the race. However the amount of reflection was really dependent on how well he felt he was paddling up to that race. Good paddling gave him confidence and enabled him to dismiss mistakes comfortably in training, but not in competition. He definitely felt that there was a need to cope with his perceived failure and to set standards of performance more appropriately and in line with his assessment of his form at that time. There was also some consideration of attempting to 'just perform' without too much judgement and to see whether this was a better approach to competition. This would be part of the confidence building he needed at that moment.

Specific issues related to technical improvement at olympic level are often difficult to identify in terms of exactly what is wrong, especially when put in the context of skills at an advanced level on difficult water or in complex problem situations. This was not seen directly as a threat to Subject 3's confidence, but it could be a possible underlying factor as it meant that he may not have felt he was improving.

Subject 3 knew he was fast enough, from analysing his times that year at the races. His fitness preparation had been good and this had given him confidence in his preparation. However, there was still a tendency to go that bit faster by cutting corners and then incurring penalties.

On examining his previous year's training from the training return graphs, he felt that they more or less mirrored an ideal training shape. There had been a tendency though to concentrate on the physical at the expense of technical work and particularly mental preparation.

His planning for the coming year was to adhere to the same physical training, but to make time for more technical aspects which required long term and specific goals. There was also a need for a great deal of psychological confidence building. After the interview Subject 3 did agree to fill in the SPSQ, and to compile a performance profile, using self constructs, the results of which are given in **Tables 6 and 7** respectively.

Table 6 Scores from the SPSQ for Subject 3

Category	Score (Max.48)	Deficit (Max score-subject's score)
Imaginal Skills	34	(-14)
Mental Preparation	31	(-17)
Self-Efficacy	38	(-10)
Cognitive Anxiety Control	36	(-12)
Concentration Skills	33	(-15)
Relaxation Skill	37	(-11)
Motivation	45	(-3)

Table 7 Performance profile self-constructs and definitions for these attributes as derived by Subject 3

Construct	Subject 3's definition of constructs	Current score (10)
Motivation	Drive, ability to push forward when things not so hot. Sticking power	10
Patience	Not thinking it is going to happen overnight. Coping with failure, take it in your stride.	3
Self-Confidence	Inner belief - own ability, strong enough inside to dismiss mishaps	6
Level Headed	See results in perspective - don't get distressed if session or race performance not good. Realise highs and lows inevitable	7
Ability to Analyse	Look at things, draw judgements about courses. Training analysis also look at your own life	9
Ability to Dismiss Failure	Within sport and life. If you are paddling badly I feel it is the end of the world	5
Concentration	Be able to focus thoughts, attention to specific issues/acts that tie in Training and Racing	8

The current rating and the target scores for the performance profile are shown in **Table 8**

Table 8 Attributes, current scores, and target scores derived from the self-constructs for Subject 3

Constructs	Current Score (Max.10)	Target Score (Max.10)
Motivation	10	10
Patience	3	5
Self-Confidence	6	8
Level Headed	7	8
Ability to Analyse	9	7
Ability to dismiss failure	5	8
Concentration	8	10

5.5.3 Formulation

A). The interview elicited strong responses of:

a) lack of self-confidence

b) allowing other people and situations to lower your self-confidence and self-esteem

c) loss of concentration in races when a mistake is made

d) failure to identify technical targets and set goals which can be monitored

e) being quick enough in races but sometimes making mistakes

f) need to check technical competence regularly

B). The questionnaire showed a great deal of agreement with these problems, namely:

a) lack of positive imagery

b) little mental preparation that was effective

c) little self confidence

d) poor concentration skills

e) limited relaxation skills

5.5.4 Selection of Intervention

In view of the number of problems that were present it was decided to concentrate on two issues which may in turn help eliminate some of the other problems. It was felt that the real need was to build up self-confidence and concentration. The long term goal being to allow Subject 3 to go into races mentally tough and in a state of mind that did not allow any distractions before and during the race. At the same time there was a need for Subject 3 to be able to adjust to changing circumstances. Additionally, because he was very organised, it was decided to set out the intervention in a format that gave both targets and explanations. These are shown in **Table 9**

Table 9 Intervention strategy target themes and explanations for Subject 3

Target themes explanations	Strategy
Self-Confidence Programme	
(a) Need to build confidence in technical excellence	Use identified targets for goal setting, measure and evaluate.(Weinberg & Gould, 1995). Don't compare with others, if your session is about getting onto form.
(b) Reject thoughts of failure	Use a thought stopping technique (Meyers & Schleser, 1980)
(c) Prevent confidence from draining away as competition draws nearer	High quality workouts. Flowing gates on moving water. Go back to remembering how good your physical preparation has been. Remind yourself of your technical goal achievement. Identify your best performances (Feltz, 1984), and replay until you get this competition's course plan.
(d) At competition site keep all thoughts positive,(Rotella et al. 1985). (Don't let thoughts of disgrace arise and Dismiss fear of failure)	Use imaginal training here.(Singer, 1988). Doing the moves in a relaxed state. Any doubts "THOUGHT STOP" use a relaxation/centering to bring you back to positive thoughts.
(e) In training talk yourself (Silva, 1982) into doing well. Do not worry about other competitors rather use them to help you with your analysis (saving your energy). Only identify with their technical single moves.	Analyse the move, use observation. Don't identify with the paddler. Decide whether you should copy. Evaluate your own performance and not yours against theirs. Improve on yours. Give yourself a score out of ten each time.
(f) Have a system (Syer & Connolly, 1984) both in training and competitions where you familiarise yourself with the site.	Be alone - walk around, notice controls, water, close your eyes, listen to noises. Take in smells. Draw a map of the site. Walk around this site in your mind. Put on a walkman, with the sort of music you may hear at the competition.

(g) Relaxation before a competition to prevent subjects 3's view that he is too tense	Use relaxation tapes (Hardy &Fazey, 1990) to develop appropriate strategy. This will require some experimental work to decide which is best, then: Develop competence in this system to the point where it requires only short period, to use effectively. Use before full runs. Centering may also be very useful here when you are on the start line.
(h) Feeling in your comfort zone is important before the big race begins	See the race as a problem with many really enjoyable challenges. (Bunker et al. 1993). You will feel comfortable when you realise you can dominate yourself and the situation, nothing eat into you.
Concentration Programme	
(a) Need to build concentration skills	Use concentration tape at home At training site have switch on/off strategies.(Horsley, 1995) Not allowing distraction to come into play. Use a relaxation tape and develop the skill to switch to relaxing anywhere. Practise in training and prior to competitions. Enjoy it.
(b) Not allow a mistake to dwell in the mind	Thought stop. Re-focus on the correct line. Enjoy race. In training after every mistake however big or small carry on through at least the next two gates. Don't dwell on what happened but identify why and how you are going to put it right.
(c) Prevent distracting thoughts entering your head	Thought stop technique to be acquired. Then, re-run an event in your head, at Gate 6 start planning your paid work. Thought stop get back on track. Do again remember what you had for breakfast. Thought stop. Quicken this up. Use in training, any distraction on or off the water in your concentration period. Thought stop back to job in hand.

Subject 3, by his own request, was directed to appropriate texts in order to train his mental skills (Loehr, 1986; Orlick, 1990; Albinson and Bull, 1988; Syer and Connolly, 1988). It was agreed that monitoring should be on an informal basis when he felt appropriate. As the author was seeing him almost daily, at training sessions and socially, this seemed totally appropriate.

5.5.5 Progression 1

The informal reviews did not raise anything untoward and Subject 3 felt both his technical and mental skills were progressing well. The coach also noted a much more positive application of techniques in solving the problems that were presented on the slalom course. Subject 3 insisted that his technical improvements would have happened anyway, but he felt more confident with his knowledge of the mental training techniques. The real test would be in the first few international races and then at the Olympic selection.

5.5.6 Performance Outcome 1

Subject 3's results at Internationals were 5, 7, 11, 18, 1, and then through the selection races he qualified for the Olympic Games.

5.5.7 Progression 2

The results of the races and selection were reasonably satisfactory, but there was a lack of consistency. Evaluation of how Subject 3 felt and viewed his mental training was interesting. As he had indicated earlier, 'I am more knowledgeable, and it has probably helped me in training which overall contributes to my international performance. But it has not eliminated the problem (confidence) when I am faced with the big race and the next big one is the Olympics'. This was somewhat alarming to the author who thought that mentally Subject 3 was in good control and all was well. There were less than two weeks to go to the Olympics. On this basis it was decided to explore this issue further.

Subject 3 explained that at major events he was still experiencing a loss of confidence and an increase in doubting self-talk, at times leading to doubting his own technical decisions and losing concentration during his performance. There appeared to be a lack of integration of the mental skills in the International races.

5.5.8 Intervention 2

As there was limited time in which to attempt to help Subject 3 with his problem, it was decided to use his mental skills knowledge and to attempt to make it more 'robust' by taking a more direct Gestalt approach (Ferrucci, 1990; Clarkson, 1992). The outline details of this are given in **Table 10**:

Table 10: Outline of the detail and purpose of the Gestalt intervention for Subject 3.

Intervention	Purpose
What and How questions	Explored Subject 3's experience of the situation and to help increase his awareness of 'what's so'. Avoided use of 'why' questions in order not to increase his somatic and emotional experience.
Visualisation	Asked him to recall in detail an example of the situation. Identify more closely his complete response to the situation; cognitive, somatic, emotional, behavioural.
Chair Work	Helped him to explore the origin and underlying positive intent of the doubting self talk, through role play to express the 'gifts and needs' of each underlying sub-personality. Subject 3 wanted to feel confident and focused but tended to hide from the discomfort of problem areas and technical weaknesses. His 'Critic' wanted him to do well and was prepared to face the hard facts.
Re-framing	Rather than ignoring the doubts or getting stressed, he now had the choice of recognising them as part of his desire to perform well and acknowledgement of the consequences of poor performances.
Visualisation	Affective integration of previous work and imagined application of new responses on race day. Included metaphor of 'checking under the boat' for any fears or doubts that would otherwise be ignored.

5.5.9 Outcome 2

The Olympic race was Subject 3's worst result of that year. The race itself required that risks had to be taken to secure a fast time. Subject 3 did risk everything, but in doing so made a serious error. He did, however, acknowledge that he was happy taking the risk, and that the final intervention was most helpful. The reality was that probably this should have been the type of intervention applied from the outset. However it may have been that it was necessary to have had in place a number of basic psychological skills before the more advanced techniques could have been used.

5.5.10 Discussion

There is scarcely an aspect of competition which an individual slalom canoeist does not fear at some time or other. When the reaction intensifies near to a major competition, then consequences can obviously be serious. Though the formulation elicited from the initial assessments was probably correct, and the resulting interventions correct, it had not been clear to the author there was still an on-going problem for Subject 3. A number of issues are highlighted in this case.

First, how can the sports psychologist be sure there were real changes in the subject's behaviour, if monitoring continually yields a positive response? The subject wished to keep everything on an informal basis and he acknowledged progression was 'okay'. It could be suggested in this case that the psychologist ought to have been more challenging and been absolutely certain that the real issues were confronted and earlier on in the athlete's preparation to allow for any further intervention.

Second, the formulation raised the question that a Gestalt approach may have been better than a general cognitive behavioural approach in order to gain a successful transference of the intervention to the competition situation. Subject 3 acknowledged that the Gestalt approach had been helpful. However, his performance following such an approach was relatively poor. This could be accounted for in factors other than psychological and it may be argued that the measure of a successful intervention is the evaluation by the subject.

Third, the author was apprehensive about what was really the best approach as he felt that Subject 3 was not going to be particularly receptive to any suggestions. The close relationship the author had with this particular subject was seen to be a hindrance as there were a number of complex issues in trying to re-establish positive group dynamics with the slalom squad after the problems of pre-selection for the Olympics. Getting Subject 3 to confront some of his problems 'head on 'seemed to be inappropriate at the time. There was ample evidence from the final intervention using Gestalt 'chair-work' (Table 10) that Subject 3 was prepared to face the hard facts. He indicated that there was a need to recognise doubts and acknowledge the consequences of poor performance. This was probably a case of the intervention being 'too little, too late' On reflection by the author this was a mistake.

There was a need for a balance between causing upset and negative attitudes in the squad as a whole and the well-being of individuals. To some extent, this was a result of the problems that ensued from the pre-selection issue when the group was in Australia (see Subject 1 in 5.3.8). Subject 3 was regarded as one of the main instigators in changing the pre-selection decision. In order to keep the group coherent it was essential that all members contributed 100% to the squad. However, rather than attempting to steer this individual and the group carefully in the most appropriate way the psychologist let issues take their own course and probably subconsciously was grateful that most of the time Subject 3 was positive about everything. The real issue was being missed and only emerged when the Olympics were imminent. It is possible Subject 3 had initially been dismissive of potentially helpful interventions, by stating that 'psychology is easy, psychological testing a waste of time, your intervention did not really help.' It is suggested that he could have been fearing exposure of some of his weaknesses that really did require help.

5.6 Subject 4

5.6.1 Background

Subject 4, 27 years of age, was employed in an industry which allowed him flexible working hours and was now living in Nottingham. He had been on the Great Britain Team at various levels for eleven years, and had never failed to be selected. His only break from the team was through injury. He had been coached by the author for seven years.

Subject 4 was regarded by the squad as a 'likeable rogue', consistently late, a slave to fashion, apparently disorganised and one for much celebration. He had the wonderful gift of being able to produce the most daring fast runs on very technical courses, with apparently little preparation.

Subject 4 had enormous talent and a large number of international medals to his credit, including a World Championship Team Gold. His technical expertise and knowledge were excellent. He lived to some extent in the shadow of Subject 1, otherwise he would have been Britain's most successful paddler. He probably trained less than other members of the squad, but this was designed to produce high quality work and, as he put it, 'high quality rest'.

He was not particularly keen on reading or too much analysis regarding mental preparation. However, he did, believe that to perform well at international level required attention to technical detail and particularly in mentally rehearsing the course moves and being very aware of the immediate environment. Subject 4 was not particularly keen on a psychological assessment, but did participate, as he was interested to see how he scored in the tests. However, he did make his scepticism clear by asking the author 'How well do you think I compete on the day?' On hearing the reply that he was a great competitor he retorted – 'Well let's not spoil it with too much of this unproven mental stuff!'

5.6.2 Assessment

The SPSQ (**Table11**) revealed some relatively high scores in Mental Preparation, Self Efficacy, Concentration, Relaxation and Motivation. Imaginal Skills showed some deficiency, as did Cognitive Anxiety.

Table 11 Scores from the SPSQ for Subject 4

Category	Score (48)	Deficit (Max score-subject's score)
Imaginal Skills	35	(-13)
Mental Preparation	43	(-5)
Self-Efficacy	42	(-6)
Cognitive Anxiety Control	32	(-16)
Concentration Skills	47	(-1)
Relaxation Skill	46	(-2)
Motivation	46	(-2)

The results were not on the whole surprising, except that Subject 4 claimed he did little mental preparation and he appeared during the author's seven years of coaching him to have few anxious moments as a competitor. His self-construct profile and definitions for the attributes along with the scores can be seen in **Tables 12 and 13** respectively.

Table 12 self-construct profile of attributes and their definitions as devised by Subject 4.

Construct	Subjects 4's definition of construct	Current Level (Max. score 10)
Confidence	Able to have the courage to know you can do something. Go to the race to think you can win. To do well.	9
Motivation	To keep training uninterrupted	9
Concentration	Racing - prevent wandering. No distraction to stay in focus	7
Relaxation	In racing - to control levels of arousal	6
Determination	To keep training and to want to win	10
Focus	Attention towards keeping mind on job in hand (specific move or overall run)	8
Visualisation	Mental rehearsal of what you want to do in training in racing	6
Aggressive	State of mind that allows you to perform physical moves powerfully, e.g. crossing a jet of water from one side of the river to the other. Not wimping out.	6

(Concentration is often seen as the same as focus (Moran, 1996) and Subject 4's definition does appear to have some overlap.)

The current scoring levels that the constructs were given by Subject 4 and the future ratings he aspired to are shown in **Table 13**.

Table 13 Self-construct profile of current importance and future ratings for Subject 4.

Constructs	Current Ratings	Importance Ratings	Future goal Ratings
Confidence	9	10	10
Motivation	9	7	8
Concentration	7	10	9
Relaxation	6	7	6
Determination	10	10	10
Focus	8	10	9
Visualisation	6	7	6
Aggressive	6	7	6

5.6.3 Interview

Although it was planned to have a formal interview, this seemed inappropriate given both the nature of the subject and the fact that Subject 4 had stated he didn't want too much 'mental preparation stuff'. What was very apparent from questioning Subject 4 was that he wanted to be a little more organised, and examine his training diaries carefully. He also felt there was a need to work on specific techniques and a general enhancement of his mental rehearsal. He was particularly happy if someone would be willing to organise his files and, together with him, set out his schedule for the next four phases of training.

5.6.4 Formulation and Intervention Procedures

The rationale for the intervention procedures was based on personal knowledge of the subject and his request to only help him with some organisational aspects and to re-start his mental training techniques. On this basis the intervention was split into a number of sessions the contents of which are summarised below:

5.6.5 Sessions 1 to 21

Session 1

Re-examination of training logs and long term planning.

Subject 4 produced his training records and the coach also supplied all the physiological testing and training session notes. In fact Subject 4 was much more organised than expected. Details of his training and rationales went back a number of years. Plans were drawn up on a monthly basis up to the Olympics. Reviews were to take place monthly and technique emphasis was identified. Subject 4 requested that he start his mental training from the beginning including revision on Progressive Relaxation and Centering Techniques. He also requested informal meetings as and when necessary - 'nothing too heavy'.

Session 2

Establish Technique Areas. Plan training and competition programme. Re-educate Visual-Motor Behaviour Rehearsal. (Suinn, 1976). Set long term goals (note was taken of the need for these outcome goals to be realistic and worthwhile, and that the subject must have no doubt about his ability to be able to achieve them, otherwise this may lead to stress and anxiety). (Bandura, 1977; Earley et al. 1989; Beggs, 1990; Lewthwaite, 1990).

Session 3

Progressive Muscular Relaxation (PMR) (Jacobson, 1938) with differential adaptations (Rotella, 1985) specifically for upper body movements.

Session 4

As Subject 4 had, from previous experience of using PMR, a good background in this technique it was decided to move him onto a further adaptation to allow for speedier effectiveness. Ost's (1988) applied technique was implemented and developed over sessions 4, 5, 6 and 7.

Session 9

Relaxation applied in training sessions and simulated competition.

Session 10

Introduction of imagery techniques that had both a kinaesthetic and visual basis (Syer and Connolly, 1984).

Session 11

Check on Session 10 - revision. Adaptation and production of audio tape, on which canoeing examples were used within the text.

Session 12

Check on whether Subject 4 was likely to use an 'internal' or 'external' imagery (Mahoney and Avener, 1977). Combination, but usually greater emphasis on 'internal'. Used course plan for next training session to break down the 25 gates into seven distinctive sections. Examined those on site. Wrote down how these sequences would be tackled. Mentally rehearsed two of these by walking the lines to the gate sequences through on the river bank. (Thus using mental rehearsal as an applied technique of Imagery). Then entered the boat and onto the river. During warm-up used relaxation technique and mentally rehearsed the first section (Visuo-Motor Behavour Rehearsal, Suinn,1976), then actually paddled this part of the course. Repeated this three times. On a further 3 runs down the course the same processes were adopted with the second section added.

Session 13

Same processes adopted as session twelve, but divided course into 4 larger segments, rather than seven smaller sections. Mentally rehearsed and practised before and after each run only two of the four segments at any one time. Thus in effect the mental rehearsal involved larger sections than in session 12

Sessions 14, 15 and 16

Used mental rehearsal where appropriate on long and short courses. Response very good.

Sessions 17-21

All the previous work was incorporated in training and competition in Australasia. The only additional modification was on returning to the UK, simulated crowd noises (using loud speakers and commentary) on 3 sessions together with using local school children as a simulated audience.

5.6.6 Outcome

Subject 4's performances at international races in which he used his relaxation and mental rehearsal techniques, were very good - 3rd, 1st, 6th, 12th and selection for the Olympic race.

5.6.7 The Olympic Race

Subject 4 had put in a reasonable first run leaving him in the Bronze Medal position. But it was obvious that this time would be improved upon by most of the other top competitors during second runs. There were also a number of time losses, that would be eradicated by other competitors. Interestingly, Subject 4 spoke to me about this run in the most negative terms and in a way that was totally new to me. He was highly critical of himself with such statements as 'Winners don't make mistakes; that should have been a perfect run;

Mistakes like that I can't tolerate; I will really punish myself if I make mistakes like that in the second and final run'.

It did appear for the first time that Subject 4 was losing some control, yet he was looking forward to the final run. An excellent time had already been produced by the Italian, Ferrazi. The coach reminded Subject 4 not to be critical, to stick with his mental rehearsal and to not change anything. Subject 4 smiled and set off at what can only be described as an incredible pace, cutting every move to the narrowest safety margin. Approaching an upstream gate one third of the way down the course he made the most basic of errors in not controlling the bow of the boat. This resulted in a five second time penalty. After this it got worse.

Reviewing this second run with Subject 4 quite clearly showed he was very confident that he could win the Olympic title and yet he felt a huge responsibility towards himself and the coach if he didn't, 'As you can't kid either of them that this medal was there for the taking'. So although confident he was highly aroused and very anxious (despite using relaxation techniques) and he lost his rhythm by going too fast at the start.

He obtained a top ten position at the Olympic Games. His own evaluation suggested he performed well in all the season's races, except the Olympics, and felt in control, with just the right amount of mental preparation. The author felt he had benefited from the mental training programme, however he did still make a very basic judgement error. This error could be attributed to Subject 4 being unable to control his excitement, which resulted in him processing vital information incorrectly on that part of the course.

5.7 Subject 5

Subject five was a member of the elite squad and was also coached by the author. Despite a great deal of encouragement he did not wish to take part in any formal sports psychology. The reasons he gave for not wanting to get involved in this area of work were most interesting. He felt that it showed signs of weakness to himself and gave strength to his rivals. Paradoxically he maintained that winning slaloms was based on hard training and the development of skill; nothing else mattered. The author observed that he set very high standards for himself and would spend large amounts of time practising technical moves, often with little improvement. This did result in a great deal of frustration. He would observe that other paddlers found it relatively easy to complete these particular techniques. His inability to acquire the new skills led to outward frustration, often resulting in him abusing equipment. However, overtly he did appear to be able to disregard these problems during competition. At competitions he did require a great deal of support in the form of companionship, and was easily bored. This may have been due in part to his whole life being only centred on training and competition. He regarded himself as a great competitor on the day. He was a very committed squad member, and supported the group throughout the difficult period of the crisis over selection policies. He did not make the Olympic team, and put this down to peaking too early, having done well in the early races.

5.8 Overall Discussion

During this research recording and examination of the case studies has been extensive. Although each case study is unique, the initial assessment does give some opportunity for comparisons across subjects in which some critical issues do emerge.

Previous research has shown that elite athletes, possess certain psychological characteristics and behavioural tendencies which include: self-confidence, competitiveness, and to a limited extent coping style, locus of control, attribution style and the use of various strategies to enhance performance, e.g. mental imagery, positive self-talk. (Anshel, 1994; Cox, 1990 and Mahoney et al. 1987). It could then be assumed that such characteristics help them to be successful. However, although the empirical literature tends to show that elite performers are better at mental skills than non-elite competitors (Mahoney et al. 1987; Orlick and Partington, 1988) it does not demonstrate how these differences occur.

Slalom canoeists immediately before competition showed on the CSAI-2 high levels of confidence and low anxiety levels, (Mantle et al. 1997 Chap. 4). Yet the close examination of these case studies does reveal a number of problems that are not picked up by the CSAI-2.

A major factor that does become very evident with these slalom canoeists is that they do have a range of problems to deal with and this does give support to the view of Hardy et al. (1996a), that the elite athlete is likely to be faced with adversity on a fairly regular basis and there is a need for such performers to cope with a wide range of potential and actual problems.

The use of the performance profile was a method that elicited a way of using each subject's constructs as a starting point for possible changes in behaviour. The main factors that all these elite performers saw as important were motivation, confidence, concentration, relaxation and determination. In the majority of cases the subjects felt there was a need to improve their own ratings in some of these attributes. This would support the findings of previous researchers cited earlier. Other qualities that arose were visualisation (**Table 13**) level headed (**Table 5**) and patient (**Table 7**).

The subjects that completed the SPSQ showed varying degrees of mental skills development, but low scores were particularly seen overall in Imaginal Skills, Mental Preparation, and to a lesser degree Concentration. This, on the whole, matched the Performance Profile results. Although exact comparison cannot be made as the Performance Profile has a self-construct basis, whereas the SPSQ has the constructs already set in the form of statements.

A major factor common across all subjects was the very high level of Motivation that they thought was necessary and which they all possessed. This concurs with the views of Brodkin and Weiss (1990) and Gill (1986) that motivation tends to be a characteristic of the elite performer. This is hardly surprising given that most trained full time to pursue excellence and were going into severe debt as well as sacrificing the opportunity to develop a career early in their lives.

Self-confidence, in its various forms, was seen to be an issue of critical importance. What perhaps is even more critical is that it manifests itself in different forms and the causes are very different. In these cases, although each had different problems to deal with, it could be said that all of them had a lack of self-confidence at some stage. Specifically:-

Subject 1 was particularly concerned about his self-image, his future and the influence on his performance outcome on significant others, and these all added up to some concerns about his self-confidence, which in turn led to some feeling of anxiety.

Subject 2 had feelings of helplessness, not perceiving himself as an equal, lowered self-esteem and problems with decision making.

Subject 3's confidence was lowered when he had poor performances and didn't reach the standards he set himself in training, or where he felt others were judging him.

Subject 4 was confident during preparation, but did not perform to his expectations in major events.

Subject 5 appeared at times to be overtly very confident and did race well. His confidence did falter when he was unable to complete difficult technical moves in practice. To a certain degree it did appear he was able to hide any confidence problems and just get on with his training or competitions. However there were signs that he needed support and help, yet would never admit to this or become involved in the programmes available to him. Perhaps he was a person who needed the most help, but he chose to reject the offers and this was respected.

In all of these cases it does appear that there were factors that affected the individuals' confidence. Some may be classed as perception of control over external factors (Jones, 1995) or the individuals concerned may have felt that their perceived ability had affected their self-confidence (Gould et al. 1984). This may have been linked to what Hanton and Jones (1995) termed 'perceived physical and mental readiness' which has been shown to be a predictor of performance (Jones et al. 1990).

What is surprising in the cases of these four subjects is that they may have been portraying and giving the impression of being very self-confident. This does uphold Hardy's et al. (1996a) view that elite performers use such strategies as a means of protecting themselves against anxiety. This presumes, of course, that subjects would have interpreted their anxiety as debilitative (Jones et al. 1993). But it does seem that world class performers across a range of sports highlight the importance of confidence (Hemery, 1986). All still seem to have doubts but despite these the elite do succeed. Interestingly, these subjects at the Olympic competition appeared to have poor performances. This was mainly due to the design of the slalom course, which had a particular gate requiring the competitors to take the risk of a penalty; this situation was largely out of their control, so the gate was known as 'the lottery'. Results at this particular competition reflected the luck that played its part. They were completely different from the 1992 world rankings and the most recent international competitions. These subjects tried to minimise the factor of luck, but it was too much to achieve. On this basis, their results in their view were very good. It also demonstrates that they measure success on performance and not merely on the official result. The international results for the next 18 months were self-consistent but did not match the Olympic competition. Furthermore, the course setters concerned have never been allowed to design any courses since that particular competition

All four subjects stated the importance of concentration in both training and in the competitions (**Tables: 1, 3, 5, and 9**), and the desire to make improvements. When these subjects refer to concentration they often also refer to it as 'focus' or 'being on task' or 'paying attention'. Such terms do seem to be interchangeable (Bond and Sargent, 1995). The psychological meaning of the term is generally accepted as concentration of mental effort on external and internal events (Landers et al. 1991). Is this the same meaning that the elite slalomists are putting on the construct? Certainly they do refer to many aspects of concentration in various forms such as decision making, focusing on vital visual cues, maintaining memory, being aware of the difficult parts of the course, and the consequences of lack of concentration. So it would seem that they see it as multi-faceted, (Etzel, 1979), incorporating dimensions which involve processing situational information, and the ability to sustain this over time (Perry and Laurie, 1993), along with the capacity to focus and switch attention appropriately. (Etzel, 1979).

Subject 1's construct gives a particularly detailed description: 'Concentration on task. Ability to close out distractions. Selective focus. Sharp focus in race situation. Focus affects timing and judgement, decisions, reaction, control and precision. Sharp focus holds race together.'

The importance of attention is seen in the case of both Subjects 2 and 3. In the case of Subject 2 this involved making decisions before starting his performance and then attending to the cues as he progressed down the course, whereas Subject 3 had problems in sustaining concentration and he was also very aware of being scrutinised by other members of the group.

On re-examining both these cases it might be proposed that they were having problems with aspects of attention and the way in which it shifts. This does bear testament to the emphasis that sport psychologists place on this issue. Many believe it to be the single most important factor in elite successful performance (Orlick, 1990; Winter and Martin, 1991; Singer et al. 1991; Nideffer, 1993). Such consequences of poor concentration may result in the mis-reading of the task-related cues and the attentional focus adopted being inappropriate (Abernethy, 1993).

The above is particularly pertinent given the nature of the sport of canoe slalom, which involves manoeuvring the boat through changing turbulent water and having to react accordingly. The consequences of a mistake are not just the time penalty that is incurred but also the real possibility of physical injury. In many cases the mistake cannot be compensated for and results in heavy penalties.

Subject 1 also alluded to 'flow' as being a vital aspect of top level slalom. This has been seen by some researchers as a part of concentration where the performer is totally absorbed in the task (Privette, 1981; Williams, 1986; Brewer et al. 1991; Jackson, 1995). When slalomists are performing well the trained coach (who is outside the situation) can see they are 'flowing'. Discussion of this 'flow' with paddlers usually elicits a somewhat blank response. Further questioning reveals they are reacting automatically and not quite sure what is happening in detail. They have difficulty recalling the movements and even feelings. The recorded times for that performance do confirm a good result. When asked to repeat the performance they have difficulty in knowing how to repeat the moves in such a 'flowing' manner. However, what exactly 'flow' is in slalom and thus how it is developed and controlled seems difficult to explain, the trance-like descriptions tending by their nature to be impervious to introspection and analysis (Mahoney, 1989).

Slalom does demand that the competitor is able to attend to many different tasks, which include visual as well kinaesthetic stimuli, at the same time, thus requiring a high degree of divided attention. This then takes more of the available processing resources (Baddeley, 1986; Pashler, 1994), leaving perhaps little for dealing with unpredicted re-adjustments that may be needed to keep the boat on the fastest line. However, it may be argued that a certain amount of the cognitive processing is automatic and thereby involuntary, using relatively little mental capacity enabling processes to be carried out simultaneously, (Haberlandt, 1994). Other tasks may require the use of controlled processes which, because of the serial nature of this dimension, take up more mental resources and are slower (Eysenck, 1982).

It would be expected at this level that the slalomists had a large number of automated skills and that they were used to having to make adjustments and to attend to many different stimuli. However it is also apparent that every slalom course is different and the river flow patterns are not constant for each competitor. Additionally some courses are technically simpler than others. It is suggested that, even with expert slalomists, some conscious processing is necessary. According to Regnier et al. (1993) there is little evidence that experts differ from novices in the 'hardware' such as visual acuity, range of peripheral vision and reaction time. Regnier et al. (1993) go on to suggest that there is growing evidence that it is knowledge rather than the physical factors that the expert-novice categories differentiate in sport. This is allied with some evidence in the 'software' research that the ability to extract advance – cue information from relevant perceptual displays, make sport–specific decisions quickly and the ability to memorise structures are critical for success (Allard and Starkes, 1991; Garland and Barry, 1991). So this would to some extent suggest that in the slalom situation it is necessary to process information continually at the conscious level, but that this would not necessarily use up all the available capacity.

Observation by the author indicates that there are often errors made on simple courses by the most accomplished performers. This would support the view of Hardy et al. (1996b), that the spare attentional capacity might be devoted to task irrelevant information. (There is some evidence of this in Subject 3). There is also the possibility that this spare capacity could be used to impose some form of controlled attention on those aspects which the slalomist normally does automatically, thus interfering with such processes (Keele, 1973; Masters, 1992; Hardy et al. 1996b). This may have been the reason for the failure of the concentration intervention with Subject 2. This, however, does make the assumption that attentional resources are homogeneous. Slalom skills involve a number of different modualities (e.g. visual and kinaesthetic) and information processing activities (e.g. perception and decision making). It is possible that different processing resources are used for these different activities (Navon and Gopher, 1979).

There is also the question which Abernethy (1993) raises: whether a clear boundary may exist between controlled and automatic processes, or whether, as has been suggested by Moran (1996), such processes reside on a continuum. Moran (1996) also proposes that, in the sporting context, attention could be regarded as a skill in itself and thus could be acquired through practice. If accepted this does possibly change the strategy for the development of concentration. Coaches do help their athletes to concentrate on the most important parts of the available information, and to draw greater attention to these aspects with a whole variety of aids e.g. having markers on the boat to aid the judgement of where the bows need to be in relation to the gate poles. However it would be worthwhile attempting to get paddlers to learn about the feel of the boat in certain situations and to practise adapting to the unexpected as part of developing the ability to switch attention appropriately. It may mean we should educate from a very early stage about concentration rather than reacting to problems as and when they arise.

Examining these case studies indicates how complex the various issues can be when trying to unravel and identify the factors that are causing problems that could be having a bearing on concentration. This is further complicated as Summers and Ford (1995) have indicated by the internal determinants of attention, such as distracting thoughts and emotions. There is ample evidence from all of the subjects of this study that information does not just flow from the outside in but that much is self-generated. This in itself would point to the need to take account of individual differences. The uniqueness of each individual has been the focus of Personal Construct Theory (Kelly, 1955; Bannister and Fransella, 1986). From a Personal Construct theory point of view athletes are alike only to the extent that they employ similar ways of construing their experiences (Butler, 1989). Furthermore it does seem that there is limited understanding of the ways in which individual personalities react in the context of stress and how this may relate to performance. The sports psychology research tends to have concentrated, as has been reviewed in this study, on trait anxiety as an aspect of personality.

Eysenck and Keane (1995) have accordingly contended that little is known about the factors that normally influence the focus of attention (as opposed to the factors that are generated in a laboratory experiment). In the case of Subject 3, his goal setting at times appeared to be unrealistic, although he justified such actions. However, it caused him frustration and anxiety resulted. Additionally, Subject 3 then found his self-confidence was lowered which could have given rise for concern with regards to his concentration. The net result was an additive negative effect on performance.

The studies here suggest the need for a greater understanding of how elite athletes' mental components affect their actions. This would concur with the notion that a great deal is known about the structure of processing systems but little about their function, particularly in ecologically valid settings (Smyth et al. 1994). Such understanding may help in deciding appropriate interventions, which in the case of sports psychology are often part of a mental skills training programme (Albinson and Bull, 1988; Harris and Harris, 1984; Dalloway, 1993). A number of these interventions have evolved outside a theoretical framework and probably through trial and error (Boutcher, 1992).

The case of Subject 4 who had decided he did not wish to be involved in too much analysis but rather improve the mental techniques he had learned and used in the past does give credence to such mental skills training programmes. It also brings into focus the important issue of automaticity and processing skills. The aim of coaching is to develop skills in such a way that they become automated to the degree that allows the competitor to have spare capacity to deal with the various extra stimuli that are present on elite level slalom courses. As part of this development, goal setting is usually advocated both to help concentration and motivation and athletes are usually encouraged to focus on the performance rather than the outcome goals (Weinberg and Gould, 1995). In the case of these elite slalomists the author utilised goal setting in this way and also from an organisational point of view. The use of performance and process goals, as opposed to outcome goals, also seemed appropriate as it encouraged the slalomists to concentrate on their own performance rather than on factors outside their control, e.g. quality of the other competitors' performances, (Hardy, 1997).

Such a strategy could be seen to interfere with the automatic nature that these elite performers have developed and may have been the reason why Subject 4 wished to keep it all very simple and in his case keep the goals as a mixture of process and performance in terms of organising his training.

One way of managing the problem of interference with automaticity may be to set holistic process goals (Kingston and Hardy, 1994). In the case of these elite performers this may involve paddling large sections of a slalom course without breaking them down into smaller process components. It is quite likely that the goals would cover a number of different modes, such as physical and mental. In order to aid concentration and to provide simulation of competition, there would be a mixture of conscious and automatic processing depending on the situation. This then could be coupled with Gould et al's (1993) contention that psychological skills need to be automatic to enhance the overall performance of the individual.

The effectiveness of the interventions used has been evaluated in the case studies themselves. A problem that emerges is that, despite attempting to direct the intervention to the cause of a problem, improvement of other mental preparation techniques could be having an effect on the original problem.

A common area which emerged from all the subjects that were involved in the psychology programme centred around goal setting. As part of the intervention techniques for Subject 1 goal setting involved identifying advanced techniques that constantly need attention in training sessions. Subject 2 used goal setting as part of his strategy to aid concentration, and Subject 3 highlighted the need to identify technical targets and set goals which could be monitored. Subject 4 set long term goals and part of these was improving set techniques.

Each of the subjects was very aware of what long-term performance outcome goals they needed to achieve to be successful. Implicitly, the interviews indicated that the subjects identified performing well in international races as achieving a top 15 position. Additionally as they were all preparing for an Olympic competition, selection to the Olympic team was seen as a clear outcome goal. They were also aware that they needed to plan for this appropriately and to break their psychological training down into phases. However, what is very apparent, as a coach to a group operating at this level, is the difficulty of setting technique goals (which may be classed as process or performance goals) in this particular sport.

Apart from the problems of an individual's performance varying from day to day, there is the additional problem of the individual trying to solve the problems of dealing with the changing conditions presented by the varying flow of the river. There are also other variables which include the height of the gates above the water and their position at such minute levels of error tolerance. However, there are some factors which underpin technique, which a coach observes and tries to remedy if they are faulty, e.g. the amount of time a paddler holds the pressure on the paddle blade to effect directional change, and maintain speed.

Despite these subtle adjustments in techniques, it is very difficult for an elite level performer to see or feel any improvements. Process goals, concerned with aspects that underlie the micro-techniques making up the combined overall technique, would seem to be an obvious answer. However, it is contended that, in the experience of the author, in order to help motivation and concentration a combination of process, performance and outcome goals are set depending on the context (Hardy, 1997).

It was interesting to note that Subject 3's goals were often over-ambitious and this affected his confidence. Yet these paddlers are constantly readjusting their strategies to help them improve their overall performance and by doing so are giving themselves feedback on their effectiveness. Is this an informal aspect of setting performance goals that are meaningful to them? This would concur with the notion that such strategies motivate athletes by focusing their attention and increasing intensity and persistence (Burton, 1992).

When elite athletes are striving for long periods to make the smallest improvements then a combination of process, performance and outcome goal setting may be beneficial. This would also support the recent meta analytical reviews on the efficacy of goal setting that concluded it improved performance by over one-third of a standard deviation relative to baseline conditions (Kyllo and Landers, 1995). It is also suggested that this is a means of breaking down the performance into segments to aid concentration (Winter and Martin, 1991), which was felt to be necessary for Subjects 3 and 2. Both subjects required some definite planned targets during training and competition, in order to aid concentration and prevent distractions. However, this form of segmenting to aid concentration was found to be ineffective with Subject 2, who found it interfered with his paddling rhythm and prevented some of his automatic control.

Having 'no goals' or 'do your best goals' (Locke and Latham, 1985) would seem to be inappropriate to this elite group, although it is acknowledged that the research in this area has produced equivocal findings (Weinberg, 1994); however, most of this research until recently has been laboratory based. For these performers in a sport in which the individual competes against the clock, performance goals are important in terms of completing the various segments of the slalom course. It is acknowledged that these may be classified by some researchers as process goals when each segment is part of the final outcome. However, coaches and paddlers in slalom do treat specific segments as mini-slaloms. These segments do have, in the mind of the paddler, a particular focus and pathway which they try to follow, having previously identified that this is likely to be the most efficient way to accomplish this segment of the course. The individual will be trying to complete each of these segments as fast as possible and will be comparing, his segment times, with those of the other competitors.

A number of questions still remain in connection with the issues raised through these case studies. Self-efficacy, seen as a sport-specific concept, (Bandura, 1977) and sport confidence (Vealey, 1986) which is seen as a more generic concept, can be observed to be in operation and constantly interchanging with individuals over a period of time and in the final preparation phases. The effects of the interventions were monitored by both observation and interviews, and feedback did allow for adjustment and change. However, it is difficult to ascertain with any degree of certainty the real effect of the interventions at either the micro-sports specific level (Bandura, 1977) or the more generic macro-sport confidence level (Vealey, 1986) and what this meant for individuals in terms of their performance expectations.

There is the possibility that the group cohesion could have built up or undermined collective efficacy which could have had an effect upon individuals. This may have been particularly pertinent when the problems regarding pre-selection arose in Australia. There is also some evidence that the coach is critical in helping self-confidence of both groups and individuals in terms of modelling confidence and remaining calm just prior to an event (Feltz and Weiss, 1982; Weinberg et al. 1992; Gould et al. 1989; Weinberg and Jackson, 1990).

There was no evidence from the group that there was a problem with the author in his role as a coach; in fact there were recommendations from the paddlers that he should be nominated for the UK Coach of the Year competition. Yet the author acknowledges that in the case of Subject 3 he did not feel confident to tackle certain problems head-on and to offer very definite strategies for this particular athlete to follow. This does raise an interesting issue about the quality and effectiveness of interventions being affected by the confidence of the sports psychologist with individuals and specific techniques. This is an area which merits further research.

It is interesting to note that a number of researchers have identified psychological skills that need to be developed by practitioners among which are: self-confidence, motivation, arousal, anxiety and attentional control (Hardy and Jones, 1994; Hardy and Nelson, 1988; Vealey, 1988). These skills are a means of enhancing performance and can form part of an athlete's psychological education; they can also form an intervention response to a particular individual's identified problems.

Jones (1993), for example, has reported that elite athletes do in some cases acquire naturally, without any need for intervention, strategies for achieving relaxed states, but have also benefited from structured programmes of relaxation training. Perhaps the problem lies in the fact that there is a paucity of research that has examined the efficacy of the underlying processes of the various intervention techniques (Hardy et al. 1996a; Moran, 1996).

The purpose of this set of case studies was to assess individuals' behaviour in relation to competition, then prescribe appropriate dynamic interventions which were tested in ecologically valid settings. The studies offer some insights into the range and variety of problems faced by elite slalomists preparing and competing at Olympic level. As well as illuminating the variety of problems encountered by individual elite slalom canoeists they illustrate the interactive processes that emerge within squads.

The case studies that have been presented here do not solve any of the problems that have been highlighted. However, they do offer some evidence about how the problems may be solved. Along with this there are clear indications of the changing nature of the problems over time.

The author in his dual roles as coach and scientist was totally immersed as part of the group and the dynamics that ensued. He shared the success and failures as a group member. The effectiveness of the interventions, either proactive or reactive, was likely to have a direct effect upon him and his belief in both himself and the subsequent interventions used. It may be argued that the author in having a dual role restricted his effectiveness as psychologist. A coach, depending on his particular style, may be reluctant to adopt a confrontational approach, whereas this may have been necessary and an approach which some psychologists may have thought was appropriate in some of the more problematic and resistant cases examined in this study. Certainly, the author was very aware that he could be cited as the sole influencing agent going into major championships. On a more personal note this is not a position to be feared by the author. He has been in this position for 16 years and took full responsibility for his results good and bad. However, it does highlight the problem faced by somebody in his position having to answer criticisms which can at times be ill-informed. Results at the highest level in slalom can be affected by a number factors outside the performers' control e.g. the wind moving gates when competing. These factors are not reported in the final results, and no account is taken of them. The 'lottery gate' at the Barcelona Olympics was a case in point which virtually all paddlers and coaches agreed affected the men's kayak event. Consequently, the importance of the individual competitors making their own judgements of what constitutes a good performance in the various circumstances should never be underestimated. The ways in which individuals may be affected by operating in dual roles does, though, warrant research.

It is contended that case studies, such as those presented here, can be used to explore causal links in real-life interventions that are too complex for survey or experimental strategies (Patton, 1990). In doing this they may suggest areas that could possibly form the basis of future research, particularly the need to explain further causal relationships. Many of these areas have already been identified (see Hardy et al. 1996a, for a review) and the present study provides some evidence for the need for further research into the specific problems associated with world class performance in its competitive environment.

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CHAPTER 6

DISCUSSION and CONCLUSION

Each of the previous chapters has reported on separate aspects of canoe slalom and the findings relating to those particular aspects have been discussed. This concluding chapter brings together the most important of these findings and offers suggestions for further research. The purpose of this study was to gain a better understanding of the underlying factors that determine performance at elite level in slalom canoeing. There has been relatively little published research linking the critical factors that affect the performance of elite athletes, and there has been even less related to slalom canoeing. This does not mean that this information does not exist; in fact the author, in his role as the Olympic coach, has personally observed that there is strong evidence that knowledge of these factors is prevalent among elite slalomists. However, much of this knowledge has evolved over a period of years and very little of it has been examined systematically and evaluated in relation to performance. Vaccaro and Gray (1984) have pointed out how important it is to study the elite to gain an insight into the most appropriate scientific training methods.

In order to gain a better understanding of the current practices that exist in preparing for international performance it was deemed appropriate to conduct this study in an ecologically valid environment. A dual approach was then seen as essential incorporating both the physiological and psychological aspects of preparation. It was also seen to be appropriate to take a particular research methodological stance in attempting to gain an insight into high level performance. This involved both quantitative and qualitative approaches, allowing for empirical evaluation of the data whilst also allowing the research to be grounded in the form of case studies. The author was a participant observer. His role as coach and scientist in preparing for an Olympic Games meant that he, as well as the slalomists, had to react to situations in ways that were in the best interests of the athletes. This was action research at its most poignant and meant that the researcher stayed close to the data. In addition, it was thought that the study would be more useful if the data arose over a period of two years and, where possible, was gained at international events.

The work was non-experimental and has involved the recording, monitoring, testing, evaluation and analysis of physiological and psychological data, with a view to contributing in an informed way to current knowledge. During this time mini-pictures have appeared, rather than whole empirically verifiable results. This was to be expected in a study attempting to examine such a complex sport as canoe slalom where there is a vast number of variables. Many of these variables have probably still not been identified and could well be contaminating factors in the data. The physiological findings reported in chapters 2 and 3 have highlighted a number of important issues in relation to preparing and monitoring preparation for international competitions.

The data in this study have shown that the physiological tests for the anaerobic components show significant improvement over the first three pre-competition phases. However, in the final competition phase, which may have been seen to be the most critical, no significant improvements were found. At first sight this may have been alarming to both the performer and the coach. The last factor athletes want to be reminded about when going into an important event is that their physiological state is not improving. Such an occurrence, though, is not necessarily uncommon with elite level athletes nor is it seen as a predictor of a poor performance. There are many reports in the scientific literature describing the physiological profiles of athletes from a wide variety of sporting disciplines (Lavoie and Monpetit, 1986; O'Toole and Douglas, 1995). These and other investigations have typically identified a number of physiological variables that are positively related to successful performance in different sports (Morgan et al., 1989; Coetzer et al., 1993). However, adaptations of some of the variables from these studies tend to have been conducted with previously untrained persons (Clausen, 1977; Green et al., 1991). It has also been suggested by Wells and Pate (1988) that far less is known about either the effects of acute intensive training interventions on the performance of already highly trained athletes, or the physiological mechanisms that underlie any changes in the performance capacity. The results from the studies of untrained persons have to a certain extent acted as markers for standards and indicators of metabolic and physiological changes that take place in human beings as a result of exercise. However, it would be an assumption that this is the same response and that it occurs at the same rate in elite athletes. The results of this study do not indicate that these particular elite slalomists would necessarily follow the same rate of adaptation response as untrained persons. Furthermore, response to exercise may be dependent on the previous season's attainments in fitness levels and the extent of de-training in the individual. Elite performers may be able to develop a response to exercise more rapidly because they are able to accept the need for discomfort and can adapt to these feelings more easily because of their training experience. They may also be motivated by the rewards sustained training will eventually bring.

Preparation by the athletes for international competitions (phase four) is regarded as critical. This normally incorporates speed and pace training following regimens that have been used for several decades by many sports. Such training is normally undertaken once an endurance base has been established. Sustained exercise is conducted at an intensity that is greater than the athlete's highest current steady state pace. Such training is regarded as an enhancement to lactate kinetics (Tanaka and Matsuura, 1984; MaCrae et al. 1992) and stimulates the specific neurological patterns of muscle fibre recruitment needed at race pace (Costill, 1986; LeMond and Gordis, 1990). Although this is not a new phenomenon, little appears to be known about the rates of the physical and metabolic changes that occur in response to speed and pace training in elite performers, whose improvements, because of their high initial base line, are likely to be minimal. It would appear that there is no evidence, in the current research literature, that has established the amount of endurance and anaerobic training required by elite slalomists, nor the effects of de-training.

This study has demonstrated that the laboratory tests used produced no ($\pm$) significant correlation with performance. Some coaches may have predicted that this would have been the case given the degree to which skill plays a part in performance. However, the real question, which is vital to slalomists and coaches, is the degree to which the physiological and metabolic elements need to be trained, and at what pace to develop skills. Furthermore, it is vital to identify the levels of fitness required to maintain skills that involve bursts of power in order to keep the boat on the correct line against sustained opposing forces for periods of approximately 2 minutes.

Sleivert and Rowlands (1996) have pointed out, for example, that once $\dot{V}O_2$ max has developed to a criterion level then other factors are probably more important determinants for success. There also remains the viewpoint of Bunc and Heller (1994) that before any metabolic adaptations can be verified they need to be tested using specific performance so the trained muscles are loaded appropriately. The present study attempted to do this using a wind resistance ergometer which, the elite verified, was similar to paddling. However, it only loaded the muscles in a forward paddling constant action. Slalom is not a forward paddling action event. The slalomist needs to use a large number of power 'holding' strokes and 'combination' strokes that involve constantly changing the wrist action. The same criticism could be made of WAnT as this is even further removed from the actual paddling action. All of these factors are compounded by having a homogenous group of subjects, where differences in race performance from laboratory tests are difficult to explain (Bunc and Heller 1994).

The alternative testing protocol is to use field-testing procedures. This is not impossible and probably points the way forward. Field testing was conducted by the author with this particular group on a number of occasions primarily to see if the results obtained in the field were matched in the laboratory. This is an area that offers promising prospects for the future. Although this is not the place to discuss in detail the field tests that were undertaken, fundamentally there was an attempt to conduct a discontinuous step-wise aerobic threshold test. The subjects paddled down white water through relatively easy gates and the load was increased by the subjects having to complete the course in increasingly faster times. The main problem was that it was difficult for the subjects to paddle to fixed time even when given the split time feedback as they progressed down the course. If this field test could be conducted accurately and results matched to the laboratory testing, this would then give greater credence to the scientific tests in laboratory conditions.

However, field-testing will not necessarily provide a high correlation between the tests administered and performance; other factors beside physical fitness will still prevail. Sports involving a multitude of facets that contribute towards performance can at best only identify and monitor these aspects and possibly integrate some of the factors that may predict performance. The work of Chin et al. (1995) with elite badminton players has shown that in a sport involving a high degree of skill (as well as fitness) that there was a low correlation between field test results and the rank order list. Fundamentally, the coach needs to know that the performer is responding physically and metabolically to a training stimulus. It is also necessary to know that time spent on training is producing the most effective way of developing the adaptation responses. Levels of fitness and strength have to be sufficient to allow sustained training in white water skills at an advanced level. It is proposed that if the physiological development is such that the performers are able to easily repeat bouts of advanced skill training lasting an hour, then they will have the physical conditioning to allow them to perform a race lasting two minutes. Research has shown that seasonal variations in physiological parameters that are directly related to performance are common (Koutedakis et al. 1993). However, the data reported here do not indicate that a particular level of fitness is required in order to perform successfully at international level in slalom canoeing. What is likely to be more relevant is that there are physiological parameters that require high levels of development, particularly during the preparation period of the year, in order to be able to develop the skills required in slalom. This is particularly the case when high levels of lactate are likely to be encountered. Slalom, even when developing skilled techniques, is conducted at a highly intense pace. Twice daily training at this rate for a substantial period of the year would not be possible without highly developed levels of physiological adaptation. It is suggested that the limiting factor to success as inferred by the research reported here is not physiological conditioning, per se. Rather, the conditioning could be limiting the extent of skill development that in turn limits performance.

This does raise the issue concerning the function of physiological testing in sports such as slalom. If it is accepted that there is no relation between the laboratory tests and performance in international competition, then what purpose does testing serve? On the one hand it is often argued that science can contribute to developing better levels of specific physiological parameters related to particular sports. On the other hand for this to be of any real relevance it does require that the testing is related to some effect on the eventual performance outcome. Certainly there is a case for evaluating a particular training regime and seeing its specific effect. Being able to monitor the training and to assess the current status of fitness may also serve as a motivation for training. However, a note of caution is needed as it may be that a physiologist might give advice on how to improve a specific fitness area, yet this may have no bearing on the ultimate performance. The elite athlete just becomes better in that physiological area and demonstrates that he (or she) has had a positive physiological and metabolic response and adaptation to a training stimulus. Such a strategy could lead elite slalomists to concentrate on those factors in their training that can be measured. Even though these areas may be important to aid training they may not, in the case of slalom, be an end in themselves. The critical ingredients for success are more complex and difficult to identify clearly, let alone measure.

The data in this study show that the volume of training did vary among individuals. There is also clear evidence that the volume of training has significant correlations with the test results during certain phases of the year. Phase one shows that significant correlations exist between the volume of training and peak $\dot{V}O_2$, and also distance. Phase two has correlations relating to: distance, mean power, $\dot{V}O_2$Rec8 and total work. Phase three has correlations relating to minimum power, $\dot{V}O_2$Rec8 and total work. In phase four the analysis did not reveal any significant relationships between any of the laboratory tests and the volume of training.

It must also be considered that the volume of training does not indicate the intensity. However, it is clear that aerobic training, by its very nature, is less intense than lactic accumulation training. The training philosophy adopted by this elite group of slalomists was one of periodisation stress (Fry et al. 1992). This process involves applying a series of stimuli that will displace the homeostasis of the subject's function system and provide a stimulus for adaptation (Matveyer, 1981). Once adaptation has been established, the subject is capable of doing a greater amount of work for an equivalent homeostatic displacement. This is often referred to as super-compensation (Bompa, 1983; Harre, 1982; Kukushkin, 1983). Provided the stimulus is applied during this period and is more demanding than previous ones, adaptation will be increased. Various manipulations of these fundamental principles of training have been devised in order to create the greatest effects. As all the training tasks cannot be worked upon at the same time, traditionally aerobic and strength work have taken the priority in the early part of the off-season (Bompa, 1983).

Training has been further classified into various cycles (Kukushkin, 1983), the microcycle lasting seven days. During this period subjects training every day would develop accumulative fatigue. On this basis within a microcycle, it is usual that technique and speed development should dominate the early part of the period when the athlete's central nervous system is at its best (Ozolin, 1971). Aerobic work would then be developed in the latter part of the cycle. It does seem, given that these general principles were adopted by the slalomists, that the laboratory testing did reflect the improvements gained through the first three phases of the year. It is also interesting to note that $\dot{V}O_2$Rec8 was to some extent used as a measure of anaerobic capacity. This did feature in phases two and three.

The 2 minute tests showed that performance, as measured by the distance travelled, improved overall, and this was the single factor that the slalomists used as the most important index of their training status. Similarly, they regarded total work achieved within the WAnT as an important measure of their anaerobic state of training. The amount of time spent on strength training had the greatest number of correlations with the laboratory tests. Such a finding may indicate just how important this area of training is in preparing for slalom competition.

It has been proposed above that physiological and metabolic adaptations are important in allowing athletes to be able to sustain a large number of skill repetitions in training. It is also apparent that athletes need strength and power to be able to hold the boat in position and accelerate it against large opposing forces. Failure to do this results in skill breakdown which is nearly always due to fatigue in the arms, often termed by the slalomists 'lactic forearms'. Thus the importance is evident of undertaking lactic training throughout the year as an indirect form of skill development.

The greatest volume of training time is spent on skill development (whitewater gates). This is wholly appropriate, providing that high quality work can be maintained during the sessions, and this is dependent on the level of fitness of the individuals. However, the author has observed a potential problem for some athletes in the volume of training that they undertake. The growing prestige associated with elite performance does pressure athletes to train harder and harder so that they are more likely to develop chronic fatigue, or over-training (Fry et al. 1991). Indications of over-training in slalom canoeing are not always easy to ascertain through examining performance alone. Errors may occur because of fatigue or they may be caused by skill mis-judgement.

From a practical point of view the Training Impulse (TRIMP), a quantitative unit of measurement (Morton, 1997), has been suggested as a model which uses, in a non-linear fashion, the extent to which training raises heart rate between resting and maximum. Heart rates are recorded during training bouts and matched to feelings of fatigue. Such a model in slalom canoeing deserves further research, particularly if it can be established that the concepts associated with TRIMPS have biochemical markers associated with fatigue such as those established by Verde et al. (1992); Hooper et al. (1995); Rowbotton et al. (1995). Further studies by Bannister et al. (1992) and Fitz-Clarke et al. (1991) have investigated the potential of other chemical markers such as urea, serum protein and cholesterol. Although none of these is perfectly in phase with fitness and fatigue, their time courses do appear to have a basic similarity. It is felt that this line of research would be particularly beneficial in planning training sessions which ultimately will contribute to skill development Recent work (with swimmers) has strongly indicated that there is a training threshold beyond which intensity is then the main factor to have an effect (Mujika, 1995). It would appear that frequency and volume lose their stimulation capacity beyond this threshold.

The data in this study also show that a reasonable amount of low intensity training is undertaken in the form of anaerobic threshold, aerobic and general paddling. Such training has an obvious effect on the aerobic components, but it also has the function of motor-patterning that is required for better skill production in the form of 'feel', particularly in relation to the combination strokes that are necessary in slalom. This supports the notion of low intensity patterning proposed by Mujika (1995). Such low intensity training does relate to $\dot{V}O_2$; in skiing, Bosco et al. (1994) has claimed that $\dot{V}O_2$ is related to performance and yet ski races are only just over two minutes in duration, so perhaps patterning also plays a part in skill development within skiing.

It was perhaps too much to expect that the data analysis would reveal a relationship between training volume and the phases of training and slalom performance. There are too many variables that would influence such relationships. However, the volume of whitewater gate training in relation to performance measures does come close to being positively significant.

The skill factor in homogeneous groups of top athletes is often the distinguishing factor from non-elite groups (Schenau et al. 1996). This states the obvious, but what is urgently required is research that can isolate the factors (and these may be combined groups of factors) that make for success and ascertain ways of monitoring these in a reliable and ecologically valid manner.

This study has shown that the volume of strength training correlates with a number of laboratory measures. Even though the laboratory measures did not correlate with performance, it is suggested that strength may play an important part both directly and indirectly in performance. If this strength factor could be measured in such a way that it included the ability to hold a moving boat against the pressure of an opposing measured force then this would be a great advance. This is a suggested area for further research.

The measurement of whitewater gate skills is more complex. The elite squad did identify a large number of skills that they regarded as important for advanced level paddling in slalom. These were used to monitor skill development for individuals. They have some limited use in isolation but the real test is being able to paddle a variety of set courses without incurring penalties and at the fastest speed possible. The author would maintain that elite canoeists, in training sessions, can paddle a 25 gate course three times consecutively without incurring gate penalties and in a time that will be within 1.5 seconds of the winner. This utilises so many factors that make up performances but particularly the ability to keep the boat moving at high speed through 25 gates. Many athletes are strong, fast and skilful, but are unable to apply these attributes for the whole of the course. Physical training will improve both the physiological and metabolic systems, and skill can also be developed though these factors alone are incomplete. The psychological element appears to play a vital part in performance.

Chapter four has analysed psychological data which had been collated to establish whether there was any relationship between the sub-components of the CSAI-2 (Martens et al. 1990) and performance. Further analysis was conducted to explore Hanin's (1980) proposal of a Zone of Optimal Functioning.

The findings, in relation to the elite slalomists used in this study, show that there were no significant relationships between performance and CSAI-2 scores obtained for somatic anxiety, cognitive anxiety and self-confidence. These results were not confounded by variations in skill level which has been a criticism of inter-individual comparisons (Gould et al 1987; Martens 1977; Sonstroem and Bernardo, 1982) as the performance and CSAI-2 score were standardised within subjects and intra-individual comparisons made. Further, the results did not support the notion that multi-dimensional anxiety is likely to predict, in relation to performance, a negative linear relationship with cognitive anxiety, a quadratic relationship with somatic anxiety, or a positive linear relationship with self-confidence (Martens et al. 1990; Burton 1988). The data clearly demonstrated that high levels of anxiety or lack of confidence as measured by the CSAI-2, were not related to performance, either individually or across the group of subjects.

There was no evidence of any interactive effects (Hardy and Fazey, 1987) in the present data. Swain and Jones (1995) have pointed out that anxiety research has relatively failed to predict a substantial amount of performance variation. However, research has been reported in which directional and frequency of symptoms indicates a larger proportion performance variation can be accounted for by directional factors rather than intensity (Jones et al. 1993; Jones et al. 1994). Further reports have indicated that the interactive effects show that cognitive anxiety is not necessarily detrimental, depending on the physiological levels of arousal (Hardy and Parfitt, 1991; Hardy et al. 1994) and this has been reinforced by more recent work (Hardy, 1996b; Edwards and Hardy, 1996).

It would seem clear that despite the subjects completing the CSAI-2 in international events and as near as possible to the start of competition, the results have not supported any of the cited current research findings. It is difficult to offer explanations for these results. However, it may be suggested that administering the CSAI-2 questionnaires fifteen minutes before a competition was not necessarily the best way to elicit an honest response. Competitors are unlikely to admit to experiencing problems at this stage which may then become a self-fulfilling prophecy.

It could also be argued that the measuring instrument was not sensitive enough to seek the more subtle anxiety measures that may be found only in elite level performers. Confidence levels with these performers are relatively high and this may be a defence against the detrimental effects of anxiety (Hardy, 1990). So although this study did not reveal any facilitative/debilitative influence of anxiety, this may have been over-ridden by the force of confidence displayed by the slalomists. Certainly, it would be worth replicating the study in further research and examining the direction and frequency of symptoms and this relationship with performance. It is also suggested that this is done post-event to avoid the fear of the self- fulfilling prophecy which might be attached to negative responses. There would also be a case for re-examining other emotions that may affect performance. Recent work by Males and Kerr (1996) has demonstrated with elite level slalomists that, irrespective of varying levels of anxiety, other feelings such as pride, excitement or relaxation had little effect on performance. A search for other emotions may be revealing.

The author, in his role of coach, has observed, as it has been expressed by the slalomists themselves, that anxiety is felt during a race and this affects the technical aspects of performance. This is particularly noticeable when the first part of the competition has some highly technical manoeuvre on a 'big drop' on the slalom course, e.g. an extensive steep weir. This causes anxiety in the most experienced performers, yet if these same moves are further down the course they are not felt to be as difficult! This is usually explained by the fact that once the competitor has started to complete the early part of the course he is involved in executing the necessary skills and that there is little information capacity left to process (and therefore worry about) problems ahead. Alternatively, experiences of success over the earlier part of the course may enhance self-confidence over the lower section of the course. (Bandura, 1977).

The widely fluctuating feelings that slalomists report having experienced during a race after the event are not, in the author's view, reflected in the CSAI-2 results. At the same time, the ability to approach the start of any major championships with high levels of confidence and showing no fear may just be a result of previous successful experience (Bandurra, 1977). The selection system is designed to replicate the conditions of actual major championships and therefore selection is based on results only; mitigating circumstances play no part in the selection. Competitors coming through this system appear to have developed a coping strategy which they adopt on the start line which may include re-labelling anxiety from negative to positive (Kerr, 1990; Jones et al. 1994; Jones and Swain,1995).

However, it is recommended that future research investigate, with elite performers in international competitions, ongoing feelings during the race. It is suggested that this is done post-race by examining video footage and eliciting the feelings the competitor experienced while paddling the course. The author predicts there would be substantial differences depending on where the difficulties were situated on the various courses. It is also suggested that competitors may be able to suggest their preferred levels of arousal and their felt levels of arousal so that the researcher could examine whether large discrepancies between these two parameters affect performance (Svebak and Murgatroy, 1985).

It is interesting to note that Swain (1992) reported that basketball players could have the same CSA1-2 scores from one event to another and yet their interpretation could be negative or positive. This does beg the question to what degree can the explicit nature of pencil and paper tests that were used by the author of this thesis be taken as ecologically valid compared to the information (some of which may be implicit) which is obtained through case study? However, this does not mean that data generated by such methods are invalid, especially if they form part of a battery of data-gathering techniques.

Perhaps the data as presented in chapter four were unexpected, particularly concerning the relationship with Hanin's (1980) Zone of Optimal Functioning. The results suggest that the slalomists performed better when outside the zones defined by Hanins's criteria. This is, on the face of it, somewhat surprising as the zone is often expressed by coaches and athletes as the parameter range within which they feel most comfortable. This nearly always reflects a mental state that is the result of feeling in tune with the technical feel of the boat and the total context international competition. It could be suggested that it is still not known what this zone is, apart from a statistical measurement around a best performance and matching CSAI-2 score.

Elite performers, by the very definition of elite, may have the ability to counter any difficulties that confront them related to competition. Such an ability may mean their ZOF is very wide and cannot be pinned down to scores that are meaningful. On the other hand, the CSAI-2 may not be providing a sensitive enough measure or at least one that (as has been shown) is related to performance. If that is the case, perhaps it is not surprising that the CSAI-2 scores and best performance scores would not form an accurate and useable zone in practice.

The results of this study show no clear evidence that ZOF operates for slalomists and this might support the recently published work on 'invariant athletic behaviour' (McGarry and Franks, 1996). The research has demonstrated in championship squash match play that previous behaviours are not necessarily going to transfer to future events, unless all the conditions are the same. Conditions are never the same from one race to another in slalom, therefore 'invariant athletic behaviour' may not be transferred from race to race by slalomists. This is an area worthy of further investigation by gathering information related to behaviours across events over a sustained period. What causes these behaviours is unlikely to be measurable in a generic sense. However, individual case study, which can be largely interpretative, may allow a specific analysis to be generalised. In fact, the case studies reported in Chapter 5, although individual, have to some extent crystallised into suggested generalisations.

The main findings in Chapter 5, which were generated through a combination of interviews, construct formation and the use of a mental skills assessment (SPSQ) together with the results of the ongoing interventions, were most revealing. The most important features for success were motivation, being able to relax, concentration, confidence, and determination.

Clearly from the data provided through the SPSQ and the self-constructs, motivation was extremely high. This is hardly surprising in a group of athletes who are possibly making career sacrifices, minimising their social lives and having to go through some painful training twice a day, frequently in adverse weather conditions, on ice cold water, with limited protection for the body. This is likely to match itself to the notion of determination, including the need to succeed, and to subscribe to the idea that setbacks have to be overcome.

The ability to be able to relax is seen in the context of competition in two forms. Firstly, the slalomists see this as necessary to prevent tension of the physiological functioning which would upset the execution of skilled movements and maintenance of balance. Secondly, there is the necessity to stay relaxed in the face of competition, where mental tension may manifest itself and interfere with the pre-race decision-making process, and subsequently between first and second runs.

Evidence that concentration is also a critical factor related to success is provided from the case studies. Concentration, with these slalomists, is a flexible term meaning 'focus', 'on task', and 'attention'. Slalom canoeing does demand the ability to be able to identify relevant from irrelevant visual cues. It also requires a performer to then memorise those cues and apply their relevance to manoeuvring a boat through a complex set of fast moving water patterns. Additionally, there is the need to memorise the gate sequences and to 'attend' to staying on the fastest route down the course. Rarely does the most accomplished of performers stay on the perfect line through a sequence of gates. Therefore, the performer is having to attend to slightly varying visual and kinaesthetic cues and make adjustments.

The elite performer is often distinguished from the sub-elite by the ability to maintain his concentration over the whole of the twenty five gates that form a full slalom course. Interestingly, in Britain, winners of the swimming pool slalom championship, consisting of eight gates on flat water, are rarely in the top twenty rankings of the premier division. The author observed that it is not the fastest paddlers over a short section of gates who perform most effectively over the full course; the ultimate winners are able to concentrate and make adjustments appropriately over the twenty five gates, and be in the top five split times in four of the six sections.

The importance of concentration cannot be overstated and evidence from these elite perfomers and the author's experience would uphold such a notion. Particularly relevant is the way in which attention may shift appropriately or inappropriately (Best 1995). Selectivity (Kahneman, 1973; Pashler, 1994) is also seen as critical to performance both in attaining the technique in slalom and in applying these in the form of skill at international events. Such a notion supports the comments of Abernethy (1993) who stressed the detrimental effects of misreading task-related cues and inappropriate attentional focus being adopted. At the same time it is vital in slalom competition to be able to spread mental resources efficiently across several concurrent actions.

The ability to divide attention (Eysenck and Keane, 1995) across tasks is the result of systematic practice (Best, 1995). It is contended that the elite slalomist has developed these abilities and probably to an extreme level. What is not so clear is how the ability to prepare and sustain alertness to process several concurrent actions is maintained. On the surface it might be suggested that it is simply a skill that is developed by repeating hundreds of slalom gate sequences in a variety of situations. Support for this has been found in a study of elite volleyball players who have developed the ability to shift visual attention covertly, taking account of what is happening in their peripheral vision (Castiello and Umilta, 1992). However, this does not always fit well with observed behaviours in slalom canoeing.

Elite performers (as reported in these case studies) frequently refer to losing focus. Perhaps there is some form of external interference to which the performer momentarily pays attention which causes some contextual interference. An alternative explanation might lie in mental energy suddenly being directed inwards to a particular worry. Such a shift could cause some distress, resulting in some inappropriate action. The study also highlights the need for future research to examine both the internal and external determinants of attention in sport with elite performers. The case studies pointed to some self-generated distractions. Future research in this area would also need to take account of individual differences and adopt an appropriate research methodology rather than see these differences as a source of experimental error variance. Certainly, without good concentration (as echoed by these elite subjects) it would appear that success at the highest levels is unlikely. This inference is consistent with Orlick's (1990) view that concentration is a distinguishing feature of successful athletes.

As well as the idea that concentration is the ability to focus attention appropriately externally (and it is suggested internally), there is the importance of knowing what to do during the actual competition run when anxiety occurs. Does this require a switch of attention to deal with a potential interference? Once an anxiety producing thought has come to the conscious level, it must be using some processing space. Whether this is critical, given that there are indications that elite performers deal with a multitude of concurrent processing actions, is not clear. Intensity and types of potential interference (internal and external) occurring during competition together with their effect on specific aspects of skilled perfomance in slalom, warrant further research.

The importance of concentration highlights another relevant issue. Is there a relationship between concentration and confidence? It would be expected that if a performer felt his concentration to be highly developed, then his confidence would be enhanced, and vice versa. However, other factors which may be directly affecting confidence may then in turn affect concentration.

Self confidence was seen by all subjects as critical to their success. All subjects lacked confidence at some stage. This was manifested in various forms, which included problems in relationships, perceived current ability, control over external factors, and the ability to meet the challenges ahead. These indications of lack of confidence were a stark contrast to the results reported using the CSAI-2. The causes of the lack of confidence were varied as were the initial presentations of the apparent problems which individual subjects discussed. The case studies clearly indicated that self-confidence is both a complex issue and a dynamic construct. This was amply demonstrated in the relationship between two of the subjects involved. The effect of the dynamics in which an individual operates with a squad was also apparent on a number of occasions including the overseas training in Australia.

The study also highlights the importance of correctly identifying the causes of psychological problems and then adopting the appropriate interventions. In some cases the issues presented by subjects were performance focused, but subsequently these issues were found to have their roots in more personal problems. Chapter 5 discussed these in detail and also the effectiveness of the interventions that were utilised.

The interventions had varying degrees of success, this in itself would not be unexpected. However, an area of interest which the author believes warrants further research is concerned with the confidence of the sports psychologist. This may start with the psychologist making the correct diagnosis through to his belief in the interventions that are being adopted. Further questions may also be asked of the competitors and their belief in the interventions and their view of the confidence of the sports psychologist. When the psychologist and coach share the same role then this potential problem could be either diminished or amplified.

The case studies have, to quite a large degree, given an insight into the causes of the problems. They represent empirical evidence for the particular individuals. The validity of such evidence is internal, and represents the appropriateness (in the view of the author) of an approach to dealing with elite level performers in ecologically valid settings. The contrast between the evidence elicited using CSAI-2 and the case studies does indicate the importance of using a number of different modes of data collection. In this research the case studies were also grounded in action research requiring a response to situations as they arose.

However, it is acknowledged that qualitative methods, as used in the case studies, do have their limitations. When reporting the findings to the research community the results may have limited effect on the subject discipline if the findings have restricted generalisability. The case studies reported here deal with an elite population in a particular discipline; therefore these data may not be representative of athletes in general. There is a degree of difficulty in structuring such qualitative data. This has meant that, in this study, showing the interactions of the variables involved has been restricted in scope. Many of the interventions involved observing behaviours for long periods. This approach is particularly vulnerable to extraneous variables weakening the internal validity of the study (Jones, 1996). The case studies have not used any statistical analysis and there was no intention to do so. This may limit the confidence with which the interventions and their implications could be viewed by other athletes and coaches. The above does not devalue the study within its own terms of reference but does mean that the case study research is restricted by its context.

In this report the components of psychology and physiology have been treated separately. However, both have focused on their relationships with performance. In addition, within each of these separate disciplines a number of different approaches have been used to both gather and analyse data. This constitutes a partial holistic approach to examining the factors that affect the preparation of slalom canoeists for an Olympic Competition. Future research is likely to benefit from incorporating physiological aspects into the case studies.

Several recommendations have been made above for further research in connection with elite level slalom canoeing.

The identification of the mechanisms that account for the improvements in physiological parameters in terms of frequency, duration, and intensity of training.

An examination of the accumulated oxygen deficit in relation to improved performance in competition.

Further refinement of laboratory tests in an attempt to differentiate the physiological variables that could be critical to improved competitive performance.

The identification of models that focus on the interactive effects of skill and physiological training and their relationship with competitive performance.

Establishing the physiological thresholds of training with a view to identifying the point at which further training results in diminishing effects.

An examination of the effects of de-training during the 'off' and 'competitive' seasons.

The development of improved physiological field-tests with the objective of examining the correlation of these with equivalent laboratory tests, particularly those associated with strength and acceleration.

Further examination of the interactive effects of anxiety on performance, and whether anxiety is delibitative or facilitative.

The examination of the parameters of the claimed 'Individual Zone of Optimal Functioning' with reference to elite level performance.

The identification and evaluation of the effects of emotions other than anxiety that may be affecting performance.

A study of the psychological aspects of controlled and automatic processes in relation to concentration, during competition.

An examination of the notion of 'flow states' and their relationship with performance.

The effect of psychological interference (internal and external) occurring in competition.

The effect of the confidence of the sports psychologist on the efficacy of any prescribed interventions to competitors.

An examination of the effects of group dynamics (including the support staff) on the individual's performance in competition.

Chapter 6 References

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Appendix 1. Raw data

The raw data is contained on the diskette stored inside the back cover. These data are copyright and must not be copied in any form.

The data are contained in Excel spreadsheet files. The statistical analysis is not recorded here, but utilised a Genstat programme under the guidance of Dr Simon Kirby principal lecturer in statistics at Liverpool John Moores University.

The files and abbreviations contained on the diskette are as follows:

Trnrec = record of physical training

Columns A-T: workouts, whitewater workouts, rest days, athletic training, whitewater gates, flat gates, general paddling, river play, competition sessions, technical sessions, atpcp, lactic, anaerobic threshold, aerobic, atpcp, anaerobic threshold, aerobic, lactic peak, lactic accumulation.

6 subjects. Space between each subject.

Psyskill = psychological skill as measured by the Sports Related Psychological Skills Questionnaire.

Columns A-G: imaginal skills, mental preparation, self-efficacy, cognitive anxiety, concentration skill, relaxation skill, motivation.

6 subjects 4 testings Space between each subject.

Intcsai = results of the CSAI-2 questionnaire completed at international races

A =subject 1 b = subject 2 C = subject 3

1st figure = cognitive score

2nd figure = somatic score

3rd figure = confidence score

Each competition separated by a space

Homcsai = results of the CSAI-2 completed at domestic home races in Great Britain.

Format the same as for Intcsai

Hombest = best results of top 10 performances at home domestic events in Great Britain

A-J = top 10 performers

A =1st place time

B = 2nd place time

Homsix = time and position of Great Britain squad 6 subjects

Interbest = columns A –Y = time of competitors at international events. Rows = races

Intersix = times and positions of Great Britain team at international races

Pyslab = laboratory test results. Tests conducted on a canoe ergometer. 6 subjects. Space between each subject

Columns A – AL as follows:

A = date

B = weight

C = sum of skinfolds

D = blank

{OBLA at a load of 55 units}

E = $\dot{V}O_2$ L. min.$^{-1}$

F = lactate

G = $\dot{V}E$ L. min.$^{-1}$

H = Heart rate

{OBLA at a load of 60 units}

I = $\dot{V}O_2$ L. min.$^{-1}$

J = lactate

$K = \dot{V}_E$ L. min.$^{-1}$

L = Heart rate

{OBLA at a load of 65 units}

$M = \dot{V}O_2$ L. min.$^{-1}$

N = lactate

$O = \dot{V}_E$ L. min.$^{-1}$

P = Heart rate

{OBLA at a load of 67 units}

$Q = \dot{V}O_2$ L. min.$^{-1}$

R = lactate

$S = \dot{V}_E$ L. min.$^{-1}$

T = Heart rate

{OBLA at a load of 70 units}

U = $\dot{V}O_2$ L. min.$^{-1}$

V = lactate

W = $\dot{V}E$ L. min.$^{-1}$

X = Heart rate

Wingate

Y= peak power

Z = average power

AA = minimum power

AB = fatigue

AC = total work

2 Minute Test

AD = $\dot{V}O_2$ L. min.$^{-1}$

AE = $\dot{V}_E$ L. min.$^{-1}$

AF = Heart rate

AG = speed max

AH = distance

AI = recovery $\dot{V}O_2$ L. min.$^{-1}$ for 8 mins

AJ = recovery $\dot{V}O_2$ L. min.$^{-1}$ for 10 mins

AK = $\dot{V}_E$ L. for 8 min.

AL = $\dot{V}_E$ L for 10 min.