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Reviewer response to:

'Overtraining and the complexities of decision-making: Insights from coaches of elite athletes?

Firstly, the authors wish to express their appreciation to the quality and extent of the feedback provided on the initial draft of this paper. We found the comments to be constructive and informative. We have been through an extensive process of working through them individually and using them as a basis for a comprehensive revision of the paper as a whole. We have addressed many of the points raised and at the end of this letter have detailed our responses to specific suggestions and requests. Our track-change version also indicates key changes made.

The review comment included the request to separate the results and discussion. We considered this request at length but ultimately retain the view that a blended approach is preferable for several reasons. We therefore respectfully request that the results and discussion remain enmeshed. As the word count for the paper is already quite high we were concerned the separation of the results and discussion would require an associated narrative to run with the results that would increase the word count significantly. We were also very aware that the separation versus the enmeshing of results and discussion is often a matter of personal preference. Upon referring to issues of *Reflective Practice* it became apparent that both structures are adopted and therefore trust our decision to combine these sections is supported; the final consideration was the authors' desire to keep as much of the results and discussion contextualized, given the naturalistic framework applied to the decision making process that underpins the paper.

The other consideration we had to revisit several times was the matter of ethics and confidentiality. Wherever possible we have had to position the participants' anonymity as a priority. Some of the requests made had implications for placing our participants at risk. New Zealand is a very small country and rowing is by comparison a small but successful sport. We have wherever possible had to address the matter that someone could put two and two together. So in the succeeding responses we have refereed to 'perceived ethical risk'.

Herewith we wish to respond to individual, more fine-grained feedback: (responses in Italics)

- The style of the references needs to be revised extensively to meet the journal's requirements. *A full revision of referencing has been conducted to align with Reflective Practice requirements*
- P1L4. Delete the title *This has been done*
- P2L37-39. Reword this sentence to make it clearer. *Changed accordingly*
- P2L49. Provide some examples on what sports science literature provides on the topic mentioned *We have included explicit examples and a citation to address this*
- P3L53. Review the order of the references *Done as part of the full revision as stated above*
- P4L10. Review the order of the references. *Done as part of the full revision as stated above*
- P5L46-51. Long sentence - consider reword it to shorter and concise sentences – *Completed accordingly*

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- P6. Are there specific research questions to guide the present study? *Completed*
- P6L8-13. Explain how the interview questions were formulated? Also provide some sample questions from the interview guide and state their purposes. *Completed*
- P6L8-13. Explain how the interview questions were formulated? Also provide some sample questions from the interview guide and state their purposes. *Completed*
- P6L21-33. While I recognize the benefit of having the author imbedded full-time with the team for years, and established good working relationship with the coaches, I am also concern about the trustworthiness of the data provided by the coaches, especially if the author is an 'influential figure' within the organisation. Please explain how this issue is being addressed. *While this could be seen as problematic, the author in question was required to declare such an issue as part of the project. The contractual and institutional codes required the researcher to ensure research participants were made aware of which 'hat' the researcher was wearing. The research process was also informed by situated ethics (Simons, H., & Usher, R. (2000). Situated ethics in educational research. London: Routledge.*
- It is also a good practice to let readers know the exact quote mentioned by each coach so as to gather a complete picture of the topic under investigation *Here is where the above ethics consideration falls into place.*
- The data were collected at different points of competitions with different rowers, which might complicate the consistency of the data set. Please address this concern *The data collection section has been amended to clarify this issue. In terms of the interviews, this section has been refined and in addition an appendix has been included detailing interview topics and examples*
- P7L3 &19. Be consistent with the heading used *Adjusted accordingly*
- P7L8-13. Long sentence - reword to make it shorter and concise. *Adjusted accordingly*
- P8L34-38. How many times? How did the series of clarification taken place? Were all of coaches agreed to the statement/definition presented? Please explain – *Extract revised*
- P8L55. Insert a comma after the word "period" to make the sentence shorter and easy to read.
- P9L6. The reference should be written as "Halson & Jeukendrup, 2004". *Changed*
- P9L13. Provide some references for the scientific definitions adopted in the literature – *these are somewhat problematic – as the paper infers, However, we have directed readers to Meeusen et al (2006;2013) for the most informative interpretation*
- P9L48-53. This statement seems to contradict what you have mentioned earlier on regarding the definition of overtraining (P9L3-5). Please review and ensure that the argument is consistent. In addition, please check the order of the references cited. *Changed*
- P12L48-51. This quote does not seem to be related to 'monitoring the body language and the performance of the rowers" Please review *Reviewed and amended as requested*
- P13L43. Should it be a 'question mark' after the words "doesn't it"?
- P14L8. You mean "...so they're expected to be able to ..."? *Corrected*
- P14L33. You mean "...these coaches acknowledged intensive training..."? *Corrected*

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- P16L46-48. Do you know the reasons why none of the coaches were able to offer any heuristic for recognizing impending overtraining as mentioned? It is an important point to address to help the readers understand how they taken this issue. *Responded to by the researcher*
- The next three comments allude to the alignment of quotes with discussion /results. As a result a full review of all quotes was made and as a consequence quotes have been reduced, replaced, augmented or substituted to better reflect the alignment – this will be evident in the track changes version of the revised paper/
- P19L41-48. Several points were made on how coaches observed their athletes to determine whether they are at the risk of overtraining such as manifestations of body language, facial expression, how they carried themselves, their demeanour, and how they sat or moved in the boat. Again, supporting quotes are needed to support the claims and observations made from the results *We think this is addressed at the top of page 20 and the bottom of page 19.*
- P20L38. What do you mean “performance numbers”? Please explain *Explained*
- P20L51-53. On what ground that makes you believe that this coach was talking about efficacy and that was determined by a combination of body language and boat speed? Did you clarify with him/her your interpretation? Was the coach convinced? *Clarified*
- P21L18. What do you mean “...technically working worse”? *Clarified*
- P21L46. You mean “...for the sake of it”? *Amended*
- P22L51. You mean “...reducing the training load.”? *Amended*
- P23L16. You mean “...the training or competition environment”? *Amended*
- P24. Include implications of the results, acknowledge the limitations of the present study, and propose some areas for future research to advance our knowledge. *The conclusion has been augmented but we want to stress the word count has had to be factored in to our revisions.*

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RESEARCH ARTICLE

Overtraining and the complexities of coaches' decision making: Managing elite athletes on the training cusp.

Clive C. Pope[1], Dawn Penney[2] and Tiaki B. Smith[1]

[1]*Department of Sport and Leisure Studies, The University of Waikato, Private Bag 3105, Hamilton, 3240, New Zealand.*

[2]*Faculty of Education Monash University Peninsula Campus, Frankston 3199 Australia*

Corresponding author. Email: cpope@waikato.ac.nz

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Abstract

In many elite sport performance contexts overtraining is a critical issue for coaches to understand, recognise and respond to. While the indicators and effects of overtraining have attracted considerable research interest, there are no diagnostic tests that reliably predict impending overtraining. This study explored the practices and beliefs of three highly successful professional elite rowing coaches as they predicted and managed the risk of athlete overtraining during crucial periods of intensive training. These coaches took part in a series of semi-structured interviews that explored their practices, philosophies and experiences. The research draws on sociological perspectives pertinent to coaching pedagogy and more specifically, the tenets of naturalistic decision making in exploring how the coaches define and make decisions about overtraining. In doing so it recognizes that coaching involves decision-making in complex and demanding situations. The coaches were found to monitor the fatigue of their rowers through observation, communication and measures of training pace. In general, the intuitions and cues that were used by coaches had little in common with overtraining markers or indicators that are promoted in the sport science literature. Coaches' decision-making was based largely on subjective information and processes that were influenced by a range of stressors unique to their positions. We contend that the research provides an important new perspective on coaches' definitions and management of overtraining and enables management of overtraining to be better understood as a key element of coaching pedagogy in elite performance settings. In this article we argue successful coaches have unique insights into this topical area and this is worthy of future exploration.

Key words: overtraining; monitoring; naturalistic decision making; qualitative; coach; rowing

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Introduction

Coaching is an incredibly complex practice that involves the coach engaging in a sophisticated and dynamic process marked by ambiguity, expectation and intrigue. The best laid plans can be usurped by the fickleness of an ecology where knowledge, behavior, timing, challenge and reality must interact (Cushion, 2007; Jones and Wallace, 2005; Potrac, Brewer, Jones, Armour, & Hoff, 2000). In high performance settings the stakes are high and most coaches strive to develop their craft as the many and varied learning opportunities are presented 'on the job'

The issue of overtraining and the challenges associated with efforts to avoid it occurring and to effectively manage it when it does, arguably reflect the complexity and fragility of contemporary high performance coaching environments. Overtraining is a critical issue for coaches to understand, be able to recognise, and respond to (Peterson, 2003; Urhausen, 2002; Volianitis & Nielsen, 2009). From a simple training and conditioning perspective, overtraining can be described as performance decrement associated with excessive workload and inadequate recovery (Meeusen, 2006; Smith, 2003). It is recognised as a particularly important issue for elite endurance athletes, as the hard training required to optimise performance can create an imbalance between training load and recovery, increasing the risk of overtraining (Kuipers & Keizer, 1988; Smith, 2003). An important challenge therefore facing the coach is to determine how best to maximise their athletes' training load so as to increase the chance of optimising conditioning (and performance), while also alleviating the concomitant risk of overtraining (O'Toole, 1998; Smith, 2011). Incidences of overtraining have been reported to range from 5% to 64% (Morgan *et al.*, 1987, Morgan *et al.*, 1988) with rates for Olympic athletes reported at 10-28% (Gould *et al.*, 2002). This suggests that coaches continue to struggle with this challenge (Gould & Dieffenbach, 2002), despite the increasing sophistication of the various endocrine, immune, metabolic, psychometric and performance indicators (Meeusen, 2006) available to them.

This paper acknowledges that the challenges associated with overtraining are integral to coaching pedagogy. More specifically, it locates the issue within coaching conceptualised as being governed by a single axiom: that decision-making is central to all events and behaviors that follow (Mosston, 1992). From this perspective every deliberate coaching act is a consequence of a prior decision. In the 'here and now' a coach must make multiple decisions relating to diverse aspects of coaching, including how to organize a training session, a game plan, how to impart knowledge, how to manage time, how to interact with players. Coaches are continuously presented with multiple options that can appear overwhelming, yet for the sake of athlete success must be

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considered and positioned like a chain linking to a desired outcome. The constituent links are not formulaic, nor are they prescriptive. Rather, they are often based on a coach's informed appraisal of a given time, a given place and for a selected athlete or athletes. Consequently, coaching is just as much an inexact science as an exact science and as such, presents a distinct challenge for research to embrace complexity and subjectivity as integral aspects of coaching pedagogy and coaches' decision-making.

The research reported in this paper sought to respond to this challenge. It focuses on understanding how coaches whose athletes had repeated success at the highest level on the world sporting stage were able to predict and effectively manage impending overtraining. In the space of a decade (2005-2015) Rowing New Zealand made a dramatic increase in its world rankings, resulting in their elevation to being New Zealand's premier Olympic sport. These successes include a five-fold increase in elite World Championship and Olympic medals, as well as being ranked in the top three rowing nations 2009-2015. Furthermore, both coaches and rowers received numerous national and international sports awards during this time.

Drawing on interview and observation data gathered from three of the Rowing New Zealand coaches we describe how the coaches defined and made decisions about overtraining. As we discuss further below, the research aligns with a growing body of coaching literature that acknowledges decision-making as complex, inherently subjective, and central to the interactive social process of coaching (Cassidy, Jones and Potrac, 2004; Jones, 2006, Jones *et al.*, 2011; Kidman *et al.*, 2005). While locating the work within the broad frame provided by sociological studies of coaching pedagogy, we also draw on the tenets of naturalistic decision making (NDM) (Lipshitz *et al.*, 2001, Klein, 2008). NDM provides clearer insights into the decision-making processes that the coaches engage in amidst complex and clearly demanding contexts in which expectations for continued international success are explicit and from a coaching perspective 'ever present'.

Optimal conditioning, overreaching and overtraining.

In pursuit of optimal performance training loads have increased dramatically which in turn has increased the risk of overtraining (Gould and Dieffenbach, 2002), something exacerbated by the often-used practice of implementing periods of excessive workloads (Urhausen & Kindermann, 2002, Meeusen *et al.*, 2013). While optimal conditioning requires a healthy athlete and an effective training programme that balances intensive training with adequate recovery, arguably the athlete who can continue to respond positively to the greatest training load will develop the best physical

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conditioning (Smith, Hopkins & Lowe, 2011). This creates more pressure for the coach who must find the ideal balance between the benefits and risks of intensive training. The research on overtraining has lead to some confusion around the definition and diagnostic criteria (Kreider *et al.*, 1998). In response to this the European College of Sport Sciences formed a task force that has developed a position statement on the prevention, diagnosis and treatment of overtraining syndrome (Meeusen et al., 2006). An important part of this statement was defining overtraining as a verb, "a process of intensified training with possible outcomes of short-term overreaching (functional overreaching), extreme overreaching (non-functional overreaching) or overtraining syndrome" (Meeusen *et al.*, 2006, p. 2).

More recently The American College of Sports Medicine published a similar consensus statement (Meeusen et al., 2013) showing a fatigue continuum that results in performance changes ranging from increase, temporary decrease, stagnation and decrease (see Table 1). Non-functional overreaching and overtraining syndrome are the stage on the fatigue continuum where reduced performance is combined with the mal-adaptation of various physiological mechanisms. The differences between non-functional overreaching and overtraining syndrome are often subtle and based on a retrospective diagnosis on the period of performance reduction, plus prolonged mal-adaptation of several biological, neurochemical and hormonal regulation mechanisms.

Table 1. Insert approximately here

The prevalence and detrimental effects of overtraining in endurance athletes during hard training has stimulated a search for diagnostic markers that could predict its onset (Gleeson, 2002, Urhausen & Kindermann, 2002, Meeusen et al., 2013). An effective marker must be sensitive enough to predict impending overtraining enabling remedial reductions in training, and also be specific enough so that training is not reduced for an athlete who would benefit from the increased training overload (Smith, Hopkins & Lowe, 2011). This is clearly challenging, particularly when we also recognise that Fry *et al.* (1991) identified 84 major symptoms of overtraining and many other scholars have promoted a wide range of signs and symptoms of overtraining (e.g. Gleeson, 2002; Hartmann & Mester, 2000; Hooper *et al.*, 1995; Lehman & Foster, 1999; Meeusen et al., 2013; O'Toole, 1998; Urhausen & Kindermann, 2002,). Kentta and Hassmen (1998; 2002) consequently proposed a novel athlete self monitoring system that attempted to address the physiological, psychological and social dimensions of training and recovery. This system consisted of the ratings of the perceived exertion (Borg, 1998) and the total quality recovery (Kentta & Hassmen, 1998, 2002) scales.

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Despite such research and the regular promotion of various markers as effective monitoring tools (Aldercreutz *et al.*, 1986; Barron, 1985; Gleeson, 2002;, Hartmann & Mester, 2000; Hooper *et al.*, 1995; Mackinnon, 2000; Morgan *et al.*, 1987; Meeusen et al., 2013; Smith, 2000; Urhausen *et al.*, 1998) there is negligible evidence for a diagnostic marker that has the sensitivity and specificity to accurately predict impending overtraining (Halson, & Jeukendrup, 2004; Smith, Hopkins & Lowe, 2011). Furthermore, accurate diagnosis of overtraining can only be made retrospectively, after all other possible influences on performance have been excluded (Meeusen et al., 2013). Thus, during training and particularly during periods of training when overload is maximised, the coach must constantly monitor the athlete so as to judge if recovery periods and/or training intensity need to be modified in response to signs of impending overtraining. The markers proposed to predict impending overtraining are objective and scientific, yet by its very nature coaching is arguably as much an art as a science (Woodman, 1993), more subjective than objective (Nash & Collins, 2006). Not only is the accuracy of the supposed markers of overtraining questionable (Halson & Jeukendrup, 2004), but the ability of the coach to utilize them effectively is questionable.

While publications reporting on strategies to detect and manage overtraining from the sport science and medicine fraternity abound (e.g. Gleeson, 2002; Meeusen *et al.*, 2006; Meeusen et al., 2013; O'Toole, 1998;Urhausen & Kindermann, 2002,) very little attention has been accorded to coaches talking about the practice of successful coaching. From our anecdotal evidence we were intrigued by the potential discrepancy between the strategies promoted by sport scientists such as Meeusen et al., (2013) for predicting impending overtraining and those employed by successful coaches. We therefore chose to look more closely at coaches' decision-making with a specific focus on overtraining in an elite performance environment.

Making decisions as a coach: The scientific and the subjective

The challenge for the coach, positioned at the nexus of a vast array of information when managing their athletes' training, is to decide what to act on and when. How do they decide what strategies for monitoring their athletes, best complement their skill sets, knowledge, personality, while keeping in mind the environment in which they work? The multitude of such considerations infers there is no simple strategy for monitoring overtraining and that methods employed by successful coaches working are quite possibly unique, changeable and unorthodox. It is readily apparent that not everything is clear-cut and that some element of subjectivity will come into play. As indicated

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above, such a view aligns with conceptions of coaching as more of an art than science (Woodman, 1993), 'as pedagogy' and a complex and constantly changing social process (Jones, 2006). As argued by Lyle (2002) coaches must make decisions that are often based on experience, intuition and the fickle behaviours of athletes. Much of this knowledge is not situated within the scientific world, but rather the social. Coaches learning, decisions and actions reflect a dynamic between 'the scientific' (knowledge, understandings, principles and data) and 'the social'. The latter welcomes knowledge as grounded in personal experiences of coaches (see for example, Jones, 2006) and points to the value of a naturalistic approach to understanding and researching coaches' decision-making.

Naturalistic decision making (NDM): A framework for exploring situated decisions

In essence we wanted to explore the transition from 'concept to context' and learn how these coaches actually made decisions about overtraining in a real-world or naturalistic setting, characterised by the need to make difficult and potentially 'high stakes' decisions often under demanding conditions. Naturalistic decision making (NDM) (Klein, 2008; Lipshitz *et al.*, 2001) emerged in the late 1980s and was adopted to explore the role of experience in enabling people to rapidly categorize situations to execute effective decisions in real world settings. It is a framework used by researchers in medicine (Elstein, 1978, Gawande, 2003) and business settings (Isenbcrg, 1984) where the stakes can be high, decisions often have to be made in conditions of limited time, and where decision-makers are forced to make a judgment call that may have very significant consequences for themselves and others. Field research by Klein and colleagues (Klein, 2003) highlighted that many formal standards of decision-making employed in training programmes did not improve decision quality and were basically discarded as cumbersome and irrelevant in field settings. NDM research therefore turned attention to the role of experience in decision-making, as opposed to individuals making choices from available options. Prior perception and recognition of situations were foregrounded, with Klein's work emphasising that "when people need to make a decision they quickly match the situation to patterns they have learned" (Klein, 2008, p. 457) and if a clear match is made, they can follow a typical course of action. In sum, NDM has presented an option of *intuitive decision-making* (Klein, 1998; 2003, Myers, 2004).

Klein (2003) has argued that skilled decision makers often are more effective when they trust their intuitions than when they engage in detailed and systematic analysis. In contemporary contexts of elite performance coaching, it seems highly pertinent to explore this proposition and in

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so doing, extend insights into the ways in which the dynamic between scientific and subjective knowledge plays out in coaching pedagogy (Gilbert & Côté, 2013; Harvey, Lyle & Muir, 2015; Lyle & Vergeer, 2013). Following Cassidy *et al.* (2008) we recognise the prospective significance of the reflective process as a means of coaches extending their awareness of experience and meaning. While subjective knowledge connotes knowledge gained through personal experience, experience alone will not necessarily create knowledge. Experience must be reflected upon for it to become meaningful (Arnold, 1979). It is through a reflective process that coaches generate subjective knowledge whilst developing an enhanced understanding of aspects of training and performance, such as overtraining. This study provides insight into the subjective knowledge and subsequent actions of three elite rowing coaches with particular regard to overtraining.

The research context

Three experienced and highly successful professional coaches from the Rowing New Zealand elite team agreed to participate in this research. All had at least eight years experience coaching national representatives and collectively had coached nine Olympic medalists and 43 crews who had won medals at either Senior A or Senior B World Rowing Championships. As well as extensive coaching experience the coaches had also undertaken a number of coaching and sport science courses, with two having completed tertiary qualifications that included papers in sport science, sport psychology and coaching. The coaches also had extensive open access to a network of qualified and respected sport science and medicine specialists. The project received ethical approval from a New Zealand University and all possible measures have been taken to protect the identities of the three coaches. We have therefore adopted a style of writing in the findings that balances the requirements of presenting the coaches views and beliefs while trying to reduce the speculation within or beyond the Rowing New Zealand community about 'who said what'. It is for this reason we have not allocated pseudonyms or assigned any contextual detail.

A series of three semi-structured, in-depth interviews were conducted with each coach, with interviews lasting between 20 minutes and 2 hours. In acknowledging the potential complexity of the respective coaching styles, each interview was guided by the schedule but followed its own pathway. This afforded flexibility to openly explore each coach's perspective on the issues being explored and to probe and extract the multiple levels of discourse used. Moreover, this process facilitated a focus not only on the words spoken but also on the meanings intended (Wolcott, 1994). The three interviews collectively addressed (i) how the coaches' defined overtraining, (ii) why they considered overtraining important and (iii) the cues they used to determine whether or not a rower was at risk of impending overtraining. Further details of the interview schedules are provided in

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Appendix 1. The first interview was conducted at the team's training base at a date and time convenient for each coach. The first and two follow-up interviews were conducted at similar stages of the season over a period of three years, however questions to clarify interview transcripts were conducted whenever required. All of the interviews were conducted by one of the authors who was lead sport physiologist for this rowing programme. His research focused on examining a wide range of strategies for optimising performance and predicting overtraining for elite rowers as they prepared for international competition. He was imbedded fulltime with the New Zealand elite rowing team for five years. In this role he travelled with the team at every training venue and international competition that included World Rowing Championships and the Olympic Games. The interviewer's standing and trust through the years of shared experiences enabled extensive access to the coaches, something that for this study allowed an in-depth exploration of the motives and reasoning underpinning the coaches various practices employed by each coach.

All of the interviews were digitally audio-recorded and transcribed verbatim. The coaches were provided with copies of their completed transcripts within a month of their interviews, which they signed to verify that they were an accurate record of their respective interviews. Following transcription all interview data was inductively analysed using ethnographic content analysis (see Altheide, 1996, Saldana, 2009). This procedure facilitates a process that consciously avoids being too rule bound which can inhibit categories to emerge from the raw data/transcripts. Consequently, transcripts were analyzed using open coding (Gibbs, 2007), where the descriptive data were ordered for salient theoretical themes and/or issues that lay behind the text could be identified. Each transcript was read reflectively several times to promote and confirm the identification of key themes (Coffey & Atkinson, 1996). In addition, the coaches were also consulted individually and on a regular basis during the preparation of this manuscript. Any issues they had with our interpretation of their views were factored into this version the article.

Results and discussion

The analysis led to the identification of three themes in the data set (i) Personal - A coach's definition and description of overtraining (ii) risk and justification of intensive training regimes; and (iii) recognizing the signs of overtraining. These themes highlight the salient considerations with regards to the decision-making process when preparing their elite athletes for achieving in the high performance sporting arena. More specifically the data relating to these themes brings to the fore the centrality of non-scientific indicators and intuition in the decision-making processes that

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the coaches engaged in as they sought to maximise athletes' performance and so doing, effectively mediate risks associated with overtraining.

Personalised understandings: Coaches definition and description of overtraining

The coaches had spent many years working in the same sporting environment, something that had probably resulted in a shared philosophy on many aspects of coaching. It was therefore not surprising that their definitions for overtraining had a common theme, namely: training that caused excessive fatigue would lead to reduced performance. From their perspective, reduced performance was determined by an inability to maintain "normal" training workloads for an "extended" period of time despite the best intention of the rowers. An indicative perspective was

> *They may keep training, but they are just well off the pace, they just fall behind, they can't do it.*

The coaches believed that as the rowers neared the end of an intensive period of training they should experience reductions in training performance. All three coaches considered this to be normal. They also explained, however, that these reductions should be acute, that is training and competition performance should return to normal after the programmed period of recovery, which typically lasts three to seven days.

> *I like to try and build a little more intensity into it week after week so come to that (final week of the training block), they should be smashed, They should be really smashed and as long as you're not getting massive changes in [measures of training performance], I think that's acceptable because they do bounce back … and have great (performance results). We push them hard so that some weeks they are going to get fatigued and tired but tiredness and fatigue from just training is different than overtraining...*

Rowers whose performance failed to return to normal after these programmed rest periods were considered to be at risk of overtraining because '*they are coming back from their hardest week and after a break and their lightest week they are not recovering, they haven't bounced back'*. This coach verified his interpretation by stating '*they need to be out there doing the same amount of work holding the same [speeds] every day and if they can't for a long period of time … then something's not right and we might back them off.'*

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The risk of overtraining was seen as increasing as the period of time over which their performance had decreased extended, with the decrease generally determined from their training speeds. Furthermore these performance reductions were not the normal fade experienced during period of acute fatigue. They are very obvious and severe reductions:

> *Overtraining in the crudest sense of the word is when they have consistent [poor] performance … noticeable decrements in performance ... we are not talking about the gradual fade that you might get across a training week or a training block, it's quite gross and obvious.*

Probing the coaches about their views of overtraining culminated in the following consensus, that '*overtraining is a level of chronic fatigue that reduces training to the point where performance at upcoming international competitions is impaired*'. International competition performance could be impaired because of undue fatigue effecting race performance and / or reduced quality of training resulting in suboptimal conditioning. This definition is in essence subjective and individualized from a coaching perspective, as the level of performance decrease that signifies overtraining differs for each rower. The salience of subjectivity is perhaps best reflected in the view of one coach who argued '*I have had two athletes that were [theoretically] overtrained. They were continually tracking backwards for [2-3 months] but they were not properly overtrained because I don't think it ruined their [international] season.* In this instance the two rowers performance measured regularly during testing, training and competition slowly deteriorated over the 2-3 month period of training. The coach believed that while these two rowers were very fatigued during this training period this fatigue eventually dissipated and they subsequently performed well, hence they were not overtrained.

If we return to literature, it is clear that a single definition for overtraining from researchers and practitioners has proved difficult and that a wide range of definitions prevail (Halson & Jeukendrup, 2004; Kreider *et al.*, 1998,). Overtraining can be considered as prolonged maladaptation of athlete performance and various biological, endocrine, immune, neurochemical and metabolic regulation mechanisms (Meeusen et al., 2013). It is therefore not surprising that these coaches had developed their own definition, and that their definitions appeared to have few similarities to the European College of Sport Science' (Meeusen et al., 2013) position statement on overtraining (see table 1). Meeusen *et al.* (2006) and the coaches viewed reduced performance as the criterion determinant of overtraining, although the coaches discussed measuring performance during both training and competition. By comparison Meeusen *et al*. (2006) did not address how

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performance stagnation or reductions were determined. Meeusen *et al.* (2006) also proposed an overtraining continuum (see Table 1) with the diagnosis of overtraining dependent on the timeframe of performance reduction and the degree of physiological maladaptation and/or psychological disturbance. The coaches disagreed with both a set timeframe of performance reduction plus physiological and psychological factors being used to define overtraining. The disparity between the subjective and the scientific definitions for these two terms was perhaps best articulated by one coach who stated, '*I am not a subscriber to overtraining as it's laid out in the textbooks.*

The aforementioned disparity between the coaches definitions of overtraining and those presented by Meeusen *et al*. (2006) may relate to the different ways in which coaches and sport science or medical practitioners respectively conceptualise overtraining. While the coaches appear to view overtraining through a subjective lens, the sport science and medical practitioners are more likely to employ a scientific perspective that has thus far failed to determine a common definition and effective diagnostic tools (Budgett *et al.*, 2000, Halson and Jeukendrup, 2004). This incongruence has led these three coaches to ignore the lexicon of scientific terminology. The coaches were unaware of the terms non-functional, overreaching and overtraining syndrome.

While many of the published definitions of overtraining focus on reduced performance the coaches believed that sport science and medical practitioners defined and determined overtraining from tests of physiological maladaption and/or psychological disorders. This may reflect that the various sport scientists and sport physicians they have come in contact with have been seen to use solely physiological and/or psychological assessments to diagnose overtraining. One coach described an incident when one of his better athletes had been diagnosed as overtrained by a sport physician:

> *[Athlete] had gone to the [Sport Physician] because he said he wasn't feeling well. [The Sport Physician] told him he was overtrained and that he needed time off. [Athlete] was rowing well and doing good numbers (training speeds)… We carried on as normal and he went on to [perform with distinction].*

In this instance there were no abnormalities in the blood tests or physical assessments, the diagnosis was made solely on the basis of psychological assessments of mood, quality of sleep and perceptions of fatigue. The coach expressed his displeasure at this process and believed that he had information relevant to the diagnosis. Another coach described an incident where a medical practitioner gave an athlete that he considered as overtrained a clean bill of health

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recalling '*I remember one guy who had a blood test... there was nothing wrong with his blood test, but he was just down and he never came back up, he was overtrained and never recovered.'*

The inclusion of physiological maladaptation and psychological disturbance in the scientific definition of overtraining is common and these measures are commonly referred to as signs and symptoms of overtraining (Gleeson, 2002; Hartmann and Mester, 2000; Meeusen et al., 2013; O'Toole, 1998; Urhausen and Kindermann, 2002,). We believe that logistical and technical difficulties in accurately assessing change in performance (Hopkins, 1991) has forced many sport scientists and physicians to utilise physiological and psychological signs and symptoms of overtraining as proxies for both defining and detecting overtraining. There is, however, little evidence to support the notion that abnormal changes or levels of one or more physiological and/or psychological marker, reliably predicts chronic reductions in sporting performance (Halson and Jeukendrup, 2004). '

There are many possible reasons for the differences in the definition employed by the coaches compared to those of Meeusen *et al.* (2006, 2013). We believe one of the major reasons is that the coaches definition is based on performance, as this is the area they understand, have some control over and is very important since the fastest endurance athlete is most likely to be successful. Hence their definition is pragmatic and focuses on *subjective interpretation of measures of performance*. The definition proposed by Meeusen *et al.* (2006, 2013) focuses not only on the objective measures of performance but also those causal mechanisms that can be objectively quantified, which is a key tenet of the scientific method. As Halson and Jeukendrup (2004) have observed, however, the relationship between the criterion measure (performance) and the various proposed causal mechanisms determined by various physiological and/or psychological measures, is usually poor, which should invalidate their inclusion in the definition and description of overtraining.

Risk and justification of intensive training regimes

Overtraining is considered to be more prevalent when endurance athletes are involved in periods of intensive training with reduced opportunity for effective recovery (O'Toole, 1998). All the coaches held strong beliefs on the importance of training beyond the athlete's tolerance for prolonged periods, as a means of extending their physiological and psychological capacities. They believed that what differentiated success from failure in international competition came down to small fractions of a percent advantage in speed over their competitors. Therefore, optimising athletes' performance capabilities was vital for success and this was only achieved through periods of intensive training. Consequently, all three coaches considered overtraining to be an ever-present

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and legitimate risk, due to the intensity of their respective programmes. One coach explained the pressure to train not only as hard, but harder than the opposition, saying that;

> *There are always going to be crews that are going to beat you that are exceptional, but on a level playing field if you don't train as hard or harder than them, you are not going to win.*

Inevitably, pushing the training boundaries in this way, carries the risk of overtraining, but is seen as necessary in order for crews to achieve the highest levels of success internationally. Another coach reaffirmed this stance:

> *I expect them to be absolutely knackered for the last week [of the block of training]… that is what the plan is, if you have worked hard enough that is what happens. I think you've got to be careful not to cut back [the training load] too early… you've got to go a little bit past what they think they can handle to get more out of them.*

These quotes reflect that the coaches' focus was on trying to train athletes beyond what they believe they are capable of and in the process, reset the athlete's perceptions of what their bodies can handle. All the coaches spoke about gradually increasing the workload over a period of 3-5 weeks so that at the end of this period the athlete could not adequately recover, resulting in severe fatigue and performance reductions. This was followed by a taper, that consisted of a period of reduced workload, and rest that should stimulate a super-compensatory response thereby creating enhanced physical adaptations. This process of intensified training overload creating acute fatigue is an often-used method for stimulating adaptations in high performance endurance athletes (Bompa, 1999, Bompa and Carrera, 1999). The coaches all considered this process to be important for the development of their athletes but were also cognisant that it dramatically increased the chances of the athlete not recovering in the available timeframe, thus increasing the risk of overtraining:

> *When you are working with elites and you're trying to push, really push them along and get those fractions of a percent, you are on the knife edge it would be very easy for it to go either way…. it's a fine line probably between training in what they would call an overtrained state and actually overtraining and tipping them over.*

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If they're not slightly over the edge then perhaps they're not pushing the boundary of their limits enough". "You almost have to have someone [almost overtrained] or else you're not quite pushing them hard enough. This is what they've got to do as an elite rower, … if they don't do it they're not going to race to the best of their ability anyway.

You've got to push it to the limit, you don't know what the limit is so you've got to push, it's better to push up there and take a day off and recover than never to get there at all.

Although there were only a few occurrences of overtraining suffered by rowers under their care, these three coaches described numerous incidences when their athletes had been on a "knife edge" and were acknowledged as very close to becoming overtrained. All of these incidences occurred during blocks of intensive training, but the coaches were unable to shed light on the possible reasons why at these specific times, the rowers fatigue had developed to the point that they were on the cusp of overtraining. The first incident occurred early in the training year, during a period of intensive aerobic conditioning. He recollected *'they'd got to the level where they were just overworking … we were overworking them … we cut the miles down because [the athlete] was starting to row badly'.*

The next two incidences occurred near the end of an intensive period of anaerobic conditioning just prior to competition at the World Championships:

We were lucky that year we probably pushed them over the edge, fortunately the (weather) kept us off the water for a while and it allowed them to come back up again … it was very close.

Oh yeah, we've pushed them pretty hard ... I remember [Athlete] saying 'I don't think we're going to survive this' … it was pretty close to tipping them over.

In another instance, one of the coaches gave an insight into how individualised their understanding of training and over training needed to be. Talking about a rower who was recognised as having a habit of training extremely hard all of the time, and was perceived to be constantly in danger of overtraining and/or injury, he explained:

[Athlete] works bloody hard just to hang on and you could easily tip [them] over, [they've] just got to keep on going, yet [Athlete] managed to hold on for the last 3 to 4 years and [has] improved because of it.

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The coach explained how constant monitoring of the body language and performance of this rower often revealed episodes of extreme fatigue, which needed to be managed to reduce the risk of overtraining.

The challenge of ensuring that the rowers completed the required periods of intensive training while at the same time managing the concomitant risk of overtraining was exacerbated by the fact that the coaches would often have to monitor the response of the individual within a crew of two, four or eight rowers. It is therefore possible that the same training programme can result in a mixture of under, optimal and over training for the individual rowers within the same crew. One coach explained that:

> [*Athlete] is a genuine case of overtraining ... which goes to the individuality of training doesn't it? where as we train everyone the same, someone like [Athlete] obviously can't, physically probably handle that volume of work, somehow you've got to do something different with [Athlete], which is hard in a crew.*

The coaches were also aware of times when they had pushed the boundaries and their rowers required extended periods of recovery to halt the deterioration of their performance. A good example of this is described thus:

> *We had to back him right off and just really keep him out of the boat for three to four weeks, and if we hadn't ... he wouldn't have bounced back at all ... but it was always touch and go.*

Collectively the coaches had achieved numerous international successes that they believed confirmed the effectiveness of their intensive training regimes, despite the increased risk of overtraining. Their view was that if an athlete could not follow their respective programmes in the early stages of the training year they would not be competitive internationally. Therefore, any athlete who struggled to handle the training load, especially during the early "easier" portions of the programme was probably unlikely to succeed and retain their position in the team explaining *'they're coming into the elite programme so they're expected to be able to do it. It's the old story, if they can't do it perhaps they shouldn't be there anyway.'*

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Further factors to consider in understanding the coaches' approaches are that the coaches are working with a very limited pool of athletes and that the continued funding of the programme, and their ongoing employment as coaches was reliant upon maintaining success at the international level. The coaches were also aware, however, that arguably 'risky practices' in terms of the level of risk of overtraining, were an integral component of Rowing New Zealand's international successes:

> *They're coming into the elite programme so there expected to be able to do it. The old story if they can't do it perhaps they shouldn't be there anyway. You almost have to have someone breaking down or else you're not quite pushing them hard enough, so I expect them to go out and do it because they're the elite, this is what they've got to do as an elite rower, get that volume of work done. If they don't do it they're not going to race to the best of their ability anyway, You can't hold the whole crew back for one person, you can't hold the whole programme back for one person, you've got to push .... so if we wrote off the whole programme [almost all became overtrained] to get that one person who could do the work, that would give us a gold medal, whereas if we focused on the bottom level we'd never get a gold medal.*

While this approach can appear harsh, as indicated above, it has reaped many rewards for New Zealand rowing. Nevertheless, the coaches believed that *constant vigilance for overtraining cues was an important aspect of their coaching roles*. It should be noted that rowing is typically a crew sport and the crews are assigned to the coach by the selection panel. The crew is unlikely to be successful if all members are not healthy, therefore while these coaches acknowledge intensive training as an important component of success, allowing a weaker crew member to become overtrained is counterproductive. The coaches all cared for their rowers' wellbeing, but at the same time they were aware that implementing intensive training regimes that increased the risk of overtraining also increased the chance of the rower realising their goal of success. These sentiments are borne out in the following comment:

> *I definitely have a genuine concern for my rowers, I think it's probably a flaw and I had to be a little more ruthless but I was just of the opinion that you know we're trying to get a [boat] to go fast and we need the psychologically, physiologically, whatever, strongest people sitting in that boat*

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The coaches were therefore, committed to maintaining a programme that they acknowledged, carried inherent risks and challenges in terms of managing athletes during periods where they are on the knife-edge of optimal training versus overtraining. Being effective in this context centres on coaches' ability to recognise and respond to signs of overtraining.

Recognising the signs of overtraining

The challenge for the coaches was to determine what useful tools and strategies could help them to manage the heightened risk of overtraining. As indicated previously, this challenge was accentuated by the dominance of objective scientific methodologies that have thus far failed to produce reliable and valid predictors of overtraining (Halson, 2004; Meeusen, 2006, 2013). Hence, as we now illustrate, the coaches' focus is 'performance reduction' and they have developed *subjective strategies to predict impending overtraining*.

The most important marker or cue of increased risk of overtraining for all three coaches was *performance reduction*, recognition of which was reliant on *performance monitoring*. While these terms may be seen to imply or align with scientific discourses, this research revealed the extent to which in this elite and applied context, subjective discourses necessarily came to the fore in coaches' descriptions of the ways in which they gain an understanding of the rowers' performance, responses to training, and risks of overtraining.

Competition is often regarded as the best monitoring tool for determining changes in performance. It is, however, rare for elite rowers to have regular competition, with consistent environmental conditions and the same competitors competing maximally. Training workload is another common performance monitoring tool, however logistical and technical difficulties have resulted in a lack of valid and reliable measures of training performance for most endurance sports (Hopkins, 1991). In monitoring performance the coaches measured boat speed for most training sessions, implemented weekly competition sessions over various distances and raced in a regatta at least once a month. These performance-monitoring strategies only measured the speed of the boat and not the individual members of the crew, unless the rower was a single sculler. For this reason the coaches regularly added competitive rowing ergometry sessions and/or training in the smaller boats (singles and coxless pairs) to enable more effective monitoring of the individual rower. The importance and complexity of performance monitoring is reflected in the following coaches' comments:

> *It comes down to performance. If they had come and said to me oh you know look I'm [really tired] I'd go back and say look at this, you're ok, the numbers are still good, ... the*

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boat speed's still there, we're at a point in the training programme when you should be feeling like this:

You're always watching your rowers, just general mood and things like that, you're always keeping an eye on them but it's all quantified off the [boat speed and rowing ergometer] numbers that you collect.

Well actually the [unit for measuring boat speed] is a good one because I mean that's an invaluable tool really. I think that's just the best thing that we've had access to. If the numbers on the U2 (aerobic base) you know [boat speed] are not where they're supposed to be, you know, and they've been holding the right [boat speeds] for a long time and then suddenly it just goes down for a while then I have to look at them and see what's going on physically.

Performance monitoring in rowing is not a simplistic process because changing environmental conditions between and within a session can dramatically modify the boat speed. For this reason the coaches spoke about not just concentrating on absolute speed but also examining their crews' speed relative to the remainder of their squad and the team:

If you have two crews going against each other then it becomes pretty obvious one crew suddenly really drops its bundle. That's pretty easy to do.

If you've got two crews it's easier you know if the boats are neck and neck and then one just drops right off the back.

The challenge was determining the degree and timeframe of absolute and/or relative boat speed reductions and/or reductions in rowing ergometry that predicted upcoming overtraining. All three coaches expected some performance drop off during the week and possibly near the end of the 3-5 week training block. Their problem was determining what level of training performance drop off is considered abnormal and therefore a cue for impending overtraining. While they all made a number of comments on this issue, none were able to offer any heuristic for recognising impending overtraining. Such a drop off was acknowledged in one coach's description of an early cue for possible overtraining;

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They have consistent [poor] performance over 2 or 3 sessions, a noticeable decrement in performance over 2 or 3 sessions, we are not talking that gradual fade that you might get across a training week or even across a training block, its quite gross and obvious.

While dramatic reductions in training speed is an important cue for impending overtraining the more important consideration was the potential underpinning reasons for such a reduction. For example, a possible reason could be nutrition:

But what would be the level of falling off? You know a few metres, 50 metres, 100 metres if they dropped off, 500 you know it could be just purely a lack of energy and food you know on the day.

Another consideration could be the difference in how the individual rowers approached training and competition. While the coaches considered most of their rowers to be honest hard workers who followed the training programme to the best of their ability and competed maximally in all competitions, they described others as lazy trainers or inconsistent competitors:

You need to be careful because some people don't put the effort in earlier on, they'll save themselves for the last one then you've got to juggle you know you might have to do another couple or something or you don't tell them what you're doing and try and get the work out of them ... Knowing what they're like, whether they're hard workers or a bit scared at the beginning or saving themselves for the last one you can understand those people.

[Athlete] is not competitive enough day in day out [Athlete] would just do the same, same, same not worry about [trying to do faster speeds] every day ... and then believe that [they] could [race successively] on the day.

Thus, it was important for the coach to develop an understanding of how individual athletes approached training to help them understand the possible reasons for poor performances. Whether *performance reduction* was a potential sign of impending overtraining, rather than being due to the considerations mentioned above, was achieved primarily through the coaches' experience, intuition, communication and observation of a rower.

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They're your battle-hardened sort of warrior-type athletes, and so when they started falling over it was like you know maybe we need to change.

Knowing what they're like, whether they're hard workers or a bit scared at the beginning or saving themselves for the last one you can understand those people.

Communication was also considered an important cue for impending overtraining and was usually assessed in combination with the performance measures and observational strategies. Two of the coaches spoke at length about the importance of communication to determine the rowers' level of fatigue and performance reduction. Both sought regular feedback and created an environment where rowers and coaches communicated openly:

I see myself more as being like a facilitator than a coach, so yeah I reckon athlete feedback is crucial, it's how I coach, it's just me, I like to know, I like to get the athletes' input.

Well I just talk to them, I say how did that piece feel or how did that session feel … I know how it looked, how did it feel … tell me how you thought [it went] and I can tell you what I saw, and so we have interaction in that way.

Communication with the athlete focused on a variety of issues that included whether fatigue was "excessive" and if so, their perceptions of why this was so. The coaches spoke of asking directly about the rowers' fatigue but also seeking to determine their mood to gain a better insight into the level of fatigue because '*mood affects the way you act so I think it's a hard one to pick really, you know sometimes you can see it, sometimes you can't, but hopefully if you can see it you try and help them change.'* If the rowers' fatigue was "excessive" the coaches spoke of trying to determine whether they were following proper nutrition, hydration, preparatory and recovery processes plus whether they were feeling healthy.

One coach was keen for the athletes to initiate communication with him, but did not proactively communicate with the athletes to determine the level of fatigue they were experiencing during training. He believed that the reason for this stance was that the intensive approach to training meant that that the athletes were often expected to be fatigued. He went as far as to suggest that if they were not heavily fatigued then they were probably not training properly. Hence when asked about fatigue a rower would usually reply that they were fatigued, which in his view provided few

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useful insights into how to manage the programme. Moreover, he did not think it productive to have the athletes engage in discussions about their level of fatigue:

> *The trouble is if you [initiate communication with the rowers] it can start influencing what you do. You know, they're always going to be tired and if you really ask them then you start reducing your training all the time and your programme wouldn't get any momentum.*

> *If you ask them, they're always going to be tired, they always have to be tired. If you've got someone who's got an injury if you go and ask them they'll tell you about the injury you know, you almost want them to forget about it and move on. Don't think of the pink elephant you know and you think of a pink elephant, how are you feeling, well I'm not feeling good now you come to mention it.*

All coaches acknowledged that opening the lines of communication with their rowers could increase their vulnerability to athlete manipulation. Their major concern was a rower accentuating their fatigue as a questionable means of reducing training load. As one coach confessed *I'm probably a bit more savvy now, I know, I can tell if a rower is having me on.*

The coaches described the need to balance what they heard versus their observations of the athletes and their performance measures to determine whether the athletes were being honest:

> *If someone says they're feeling a little bit [tired], if the speed [has not decreased below normal], well that's bad luck, we'll keep going, but if the speed's really starting to get affected then yeah you button off. So it's a combination of [communication and performance] and you get to know your athletes as a consequence of that. You can tell they'll test you out and when you've got the numbers there to back it up it's pretty easy to tell when … they're trying to have you on.*

Observation of the athletes was considered important for determining whether a rower was suffering severe fatigue and at risk of overtraining. The most important observational tool identified by the coaches was the athlete's body language, viewed prior to, during and after training. The coaches described several manifestations of body language including facial expression, how they carried themselves, their demeanour and how they sat or moved in the boat.

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The coaches openly described the value of recognising the subtleties of body language. However, recognition could often be problematic and the different coaches tended to concentrate on selected aspects of body language:

> *It would just be looking at them, how they're going really. Look in the eyes, the face, the demeanour, the body language. A good coach, … should be there early enough to see them when they arrive and then you get a fair idea of how tired they are, how they carry the boat down to the pontoon will tell you pretty much where you want to be at. But being a top-class athlete is about being tired all the time. You can't be fresh.*

> *So they're coming up and you're looking at their demeanour and they're tired, sometimes you're thinking they're tired but they can handle it. But there comes that crucial time … and you're making the decision that they can't handle it.*

> *You look at the person and they actually look [different] and you look at them again and think, I never knew they looked like that. They actually look different you know. I remember looking at [Athlete] and I looked at her again I thought 'oh' and the facial look is totally different and then you know [it was time to] give them three days off [because] I felt I'd driven them down to the point [of overtraining].*

> *You can see the way they sit in the boat some days they might be slumping in a way they never do or they might be looking lethargic or slow and that's little indicators to me physically that things maybe they're not on top of their game today.*

Even though body language was considered important it was also considered important to balance what you saw with the performance numbers. As one coach observed '*you're always watching your rowers, just general mood and things like that you're always keeping an eye on them but it's all quantified against the [boat speeds and rowing ergometer speeds] that you collect.'*

Another observational strategy described by only one coach was changes in their rowing technique that occurred when they became fatigued. Prolonged periods of poor technique were described as a possible indicator of impending overtraining. The other two coaches didn't agree with this approach and proposed that as the rowers were all elite it was very difficult to see any fatigue related changes in technique. After further discussions with this coach it is our belief that he was talking about efficiency determined by a combination of body language and boat speed.

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Hence while there may have been some small changes in technique the major change in the fatigued rower was that they looked less efficient, that is they looked to be putting more effort into maintaining their normal boat speed:

> *Sometimes you might have the speed there but if they look like they're just working real hard to get their speed so there's things like that what's going on there it doesn't look that bad but they look like they're just working [really hard] so facial expression and that sort of thing. Then you know again it's so easy on the water because you can see the boat speed and you can tell that they've dropped off.*

> *They're holding the same speed but they're just working harder, but technically working worse, because [they are] trying to muscle it.*

Observation was considered an important tool by all the coaches with one coach going so far as to suggest that the body language of the rower is the most important cue for impending overtraining. The coaches spoke about observation being used to assess the level of their athletes' fatigue through changes in body language, movement patterns, reaction speed, posture, facial expression, demeanour, mood, concentration and stress. These largely external indicators collectively present quite a contrast to the largely internal physiological indicators espoused by Meeusen *et al.* (2006, 2013).

Furthermore, the timeframe that the coach has to make a decision about whether to maintain or reduce the training load compounds the difficulty that coaches face in assessing the risk of overtraining. The coaches acknowledged the difficulty in assessing the point at which the rower was in danger of impending overtraining. This difficulty is highlighted by one of the coaches who stated:

> *Well I wouldn't just go training for the sake of it. If we went out on the water and I figured it just wasn't going to go then no we wouldn't do it. If it's got to the stage where they were too tired then it's no use flogging a dead horse. But picking that time especially at our level is almost nearly impossible.*

Each of the coaches was effectively endeavouring to process and inter-relate information from these sources in order to determine when the threshold for impending overtraining had been reached. The over-riding impression from the data is that there are no straightforward rules or a

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simple formula to inform the decision. Rather the coaches must necessarily rely on their subjective interpretation of the information that they receive for each rower. That information comprises quantitative performance data and qualitative data from conversations and observations.

Conclusion: Understanding high-performance coaches as intuitive and skilled decision-makers

Lyle (2002), requested that '[f]ar greater attention is required to be paid to the coach's cognitive processes. ...Performance enhancement research cannot be complete without attention to the coach's application, integration and delivery of knowledge' (p. 303-304). This research has sought to respond by exploring in depth coaches' understandings of overtraining and the complex decision-making processes associated with mediating overtraining as an ongoing and integral part of coaching in high-performance settings. Our data has identified that coaches' decisions about overtraining were based heavily on their subjective knowledge but that the decision-making process they employed included multiple markers to support a perspective of self-consistency. Through the accumulation and processing of these markers each coach was able to express their confidence in their decisions. There was not a propensity toward a specific marker but rather each coach participated in a search for supporting and inter-related elements, taking into consideration the unique context and individual athlete. The three coaches believed intensive training was essential for success and that this practice increased the risk of overtraining. They relied on changes in performance, observation and often communication together with knowledge of the rower to determine cues for overtraining. Their decision-making was highly situated and intuitive. No defined measurement tools were employed, rather they favoured subjective appraisal to ascertain the point at which overtraining was imminent and an appropriate decision would be made. Each coach had his own unique approach depending on the rower, the environment and the stage of the training programme. Each approach required the processing of numerous sources of information and any proposed changes weighed up the risks versus benefits of maintaining or reducing the training overload.

The decision-making process also needs to be positioned and understood in the specific high-stakes contexts in which the coaches were working, with overt pressure for continued success created from their achievements in elevating rowing to New Zealand's top Olympic sport. This success led to an increased public profile and greater funding, which in turn resulted in greater numbers of rowers, coaches and support staff all requiring continued success to maintain their

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positions. The coaches' decisions on how to manage their athletes during the periods of intensive training were often made against a backdrop of athlete, sport code and national expectation, thereby exacerbating an already high-pressure situation. We believe this investigation highlights how a successful coach requires a vast amount of experience and confidence to support what would arguably be a highly intuitive decision.

A comparison of the strategies used by these coaches with the signs and symptoms of overtraining (Fry *et al.*, 1991, Kentta & Hassmen, 2002, Meeusen et al., 2013) show more differences than similarities or agreement. Agreement existed around decreased performance being the criterion determinant for overtraining. The area of similarity is that some of the psychological variables mentioned in the literature such as demeanour, mood, lethargy, fatigue, recovery, concentration and stress (Fry *et al.*, 1991, Hooper *et al.*, 1995, Kellmann, 2002, Kentta & Hassmen, 2002) are similar to those mentioned by the coaches. However, while various inventories are recommended to assess these psychological variables, the coaches clearly relied on relatively unstructured techniques namely verbal communication and/or observation. There were acknowledged disparities in the terminologies to describe overtraining, the methods for determining decreases in performance and the degree of performance decrease that defines overtraining. Another area of difference is the many physiological, immunological, biochemical and psychological signs and symptoms of overtraining, which were largely disregarded by these coaches.

Kennta and Hassmen (2002) discussed the importance of monitoring perceptions of both fatigue and recovery as a method of understanding the rowers psychological, social and physiological stress levels. Despite much probing the coaches were reticent about discussing issues related to psychosocial stressors, especially those that originated outside the training or competition environs. The reasons for this remain unclear but we speculate that it is a deliberate tactic, as the coaches do not wish to be perceived as encroaching into their rower's personal lives. Yet throughout the interviews the coaches showed that they were often aware that issues in the rower's personal lives exacerbated their stress levels and effected performance. We believe this important and often-overlooked area requires further examination.

We would argue that the apparent lack of any objective diagnostic marker that accurately predicts impending overtraining (Halson & Jeukendrup, 2004, Meeusen et al., 2013) has promoted the adoption of various subjective strategies by these coaches. It is more likely that the coaches have selected strategies they understand, are comfortable with, fit their coaching personalities and most importantly, have control over (Collins, Collins & Carson, 2016). Furthermore, predicting the point where normal acute fatigue becomes chronic excessive fatigue or overtraining is possibly too

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subtle and individualistic to ever be determined using scientific measurements alone. Although two of the coaches have tertiary qualifications that include sport science, all three suggested that *the management of athletes during hard training is more of an art than a science*. This perspective is best illustrated through the following reflective comments:

> *There is a real art in managing it as opposed to being completely reliant on the science, I think the science substantiates it and gives you a lot of what you need but in terms of really managing it and getting the most out of your athletes … the art side of it is more important.*

> *Yeah well you're either a scientific coach or you're an intuitive coach, an arty-farty type coach, science, art, one way or another. Either way … I guess I'm more that way … intuitive, arty.*

Despite such assertions there is negligible literature on the art of managing athletes against overtraining while the scientific and medical literature abounds. While this study has focused on decision-making by a small group of coaches in one selected sport, there is a need to further investigate how sport coaches make decisions across various codes and levels. It is also recommended that future research provides selected coaches with the opportunity to reflect on their decision-making practices and how such decisions are informed. Clearly many conceptual aspects of the coaching process must be positioned beside the personal attributes and attitudes of coaches. This investigation has highlighted how coach decision-making is strongly influenced by a subjective process, a process that to this point has sat in the too hard basket for too long (Polanyi, 1962). Moreover, the study has indicated that the adoption of NDM as a tool to investigate decision-making in a sporting context holds considerable potential.

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Table 1. Possible presentation of the different stages of overreaching and overtraining

PROCESS	TRAINING (overload)	INTENSIFIED TRAINING →		
OUTCOME	Acute Fatigue	Functional overreaching	Non-functional overreaching	Overtraining syndrome
RECOVERY	Day (s)	Days - weeks	Weeks – Months	Months - …
PERFORMANCE	Increase	Acute decrease (e.g. training camp)	Chronic stagnation or decrease	Decrease

Adapated from Meeusen et al. (2013).

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Appendices

Interview guidelines

INITIAL INTERVIEW

Background questions

These included personal details, experience, achievements and influences, philosophical understanding and positioning e.g.

- What is your personal philosophy and practices around physical conditioning, beliefs and influences? How does the NZ rowing principles guide or differ from your principles?
- What is goal of your physical conditioning practices and why is this important in this coaching environment?

Questions around defining over training and over reaching e.g.

- What do you believe "overtraining" (and over-reaching) to be and why?
- What and who influenced your understanding of this term?

Questions around the significance of overtraining e.g.

- Is overtraining an important issue for you. Aim to probe the link between the requirement for hard training to optimise conditioning and the concomitant risk of overtraining?
- Why is this issue important / not important to you? What and/or who has influenced your opinions on this?

Questions around cues used to determine whether a rower was at risk from overtraining e.g.

- How do you monitor for "overtraining/over-reaching/excessive fatigue", why do you employ these techniques and why do you believe these monitoring tools are effective?
- Can you talk about your specific experience/s with rower/s you've trained who have become overtrained.

FOLLOW UP INTERVIEW/S

Questions promoting reflection since initial interviews e.g.

- What methods and processes did you use to monitor overtraining or over reaching– please include all strategies e.g. perceptions, beliefs, social factors, body language, training workloads, performance data, medical information, physiological measures, etc?
- If you implemented any changes were they successful and how did you determine there success?
- If you implemented any changes were they successful and how did you determine their success?

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RESEARCH ARTICLE

Overtraining and the complexities of coaches' decision making: Managing elite athletes on the training cusp.

Clive C. Pope[1], Dawn Penney[2] and Tiaki B. Smith[1]

[1]*Department of Sport and Leisure Studies, The University of Waikato, Private Bag 3105, Hamilton, 3240, New Zealand.*

[2]*Faculty of Education Monash University Peninsula Campus, Frankston 3199 Australia*

Corresponding author. Email: cpope@waikato.ac.nz

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Abstract

In many elite sport performance contexts overtraining is a critical issue for coaches to understand, recognise and respond to. While the indicators and effects of overtraining have attracted considerable research interest, there are no diagnostic tests that reliably predict impending overtraining. This study explored the practices and beliefs of three highly successful professional elite rowing coaches as they predicted and managed the risk of athlete overtraining during crucial periods of intensive training. These coaches took part in a series of semi-structured interviews that explored their practices, philosophies and experiences. The research draws on sociological perspectives pertinent to coaching pedagogy and more specifically, the tenets of naturalistic decision making in exploring how the coaches define and make decisions about overtraining. In doing so it recognizes that coaching involves decision-making in complex and demanding situations. The coaches were found to monitor the fatigue of their rowers through observation, communication and measures of training pace. In general, the intuitions and cues that were used by coaches ~~for overtraining the athletes employed by them~~ had little in common with ~~those~~ overtraining markers or indicators that are promoted in the sport science literature. Coaches' decision-making was based largely on subjective information and processes that were influenced by a range of stressors unique to their positions. We contend that the research provides an important new perspective on coaches' definitions and management of overtraining and enables management of overtraining to be better understood as a key element of coaching pedagogy in elite performance settings. In this article we argue successful coaches have unique insights into this topical area and this is worthy of future exploration.

Key words: overtraining; monitoring; naturalistic decision making; qualitative; coach; rowing

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Introduction

Coaching is an incredibly complex practice that involves the coach engaging in a sophisticated and dynamic process marked by ambiguity, expectation and intrigue. The best laid plans can be usurped by the fickleness of an ecology where knowledge, behavior, timing, challenge and reality must interact (Cushion, 2007; Jones and Wallace, 2005; Potrac, Brewer, Jones, Armour, & Hoff, 2000). In high performance settings the stakes are high and most coaches strive to develop their craft as the many and varied learning opportunities are presented 'on the job'~~. Meanwhile their environment, including athletes and resources, are developed ethically and sustainably (Rynne and Mallett, 2014).~~

The issue of overtraining and the challenges associated with efforts to avoid it occurring and to effectively manage it when it does, arguably reflect the complexity and fragility of contemporary high performance coaching environments. Overtraining is a critical issue for coaches to understand, be able to recognise, and respond to (Peterson, 2003; Urhausen, 2002; Volianitis & Nielsen, 2009). From a simple training and conditioning perspective, overtraining can be described as performance decrement associated with excessive workload and inadequate recovery (~~{~~Meeusen, 2006~~ #506~~; Smith, 2003~~) #916}~~. It is recognised as a particularly important issue for elite endurance athletes, as the hard training required to optimise performance can create an imbalance between training load and recovery, increasing the risk of overtraining (Kuipers & Keizer, 1988; Smith, 2003). An important challenge therefore facing the coach is to determine how best to maximise their athletes' training load so as to increase the chance of optimising conditioning (and performance), while also alleviating the concomitant risk of overtraining (O'Toole, 1998~~ #40~~; Smith, 2011). Incidences of overtraining have been reported to range from 5% to 64% (Morgan *et al.*, 1987, Morgan *et al.*, 1988) with rates for Olympic athletes reported at 10-28% (Gould *et al.*, 2002). This suggests that coaches continue to struggle with this challenge (Gould & Dieffenbach, 2002), ~~is~~ despite the increasing sophistication of~~in~~ the various endocrine, immune, metabolic, psychometric and performance indicators (Meeusen, 2006) ~~{Meeusen, 2006 #506} sports science~~ available to them.

This paper acknowledges that the challenges associated with overtraining are integral to coaching pedagogy. More specifically, it locates the issue within coaching conceptualised as being governed by a single axiom: that decision-making is central to all events and behaviors that follow

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(Mosston, 1992). ~~(REF?).~~ From this perspective every deliberate coaching act is a consequence of a prior decision. In the 'here and now' a coach must make multiple decisions relating to diverse aspects of coaching, including how to organize a training session, a game plan, how to impart knowledge, how to manage time, how to interact with players. Coaches are ~~-~~continuously presented with multiple options that can appear overwhelming, yet for the sake of athlete success~~,~~ must be considered and positioned like a chain linking to a desired outcome. The constituent links are not formulaic, nor are they prescriptive. Rather, they are often based on a coach's informed appraisal of a given time, a given place and for a selected athlete or athletes. Consequently, coaching is just as much an inexact science as an exact science and as such, presents a distinct challenge for research to embrace complexity and subjectivity as integral aspects of coaching pedagogy and coaches' decision-making.

The research reported in this paper sought to respond to this challenge. It focuses on understanding how coaches whose athletes had repeated success at the highest level on the world sporting stage were able to predict and effectively manage impending overtraining. In the space of a decade (2005-2015) Rowing New Zealand made a dramatic increase in its world rankings, resulting in their elevation to being New Zealand's premier Olympic sport. These successes include a five-fold increase in elite World Championship and Olympic medals, as well as being ranked in the top three rowing nations 2009-2015. Furthermore, both coaches and rowers received numerous national and international sports awards during this time. ~~(e.g. since 2000 the Head Coach has been awarded the FISA coach of the year three times and both rowers and coaches have regularly won New Zealand's top sports awards).~~

Drawing on interview and observation data gathered from three of the Rowing New Zealand coaches we describe how the coaches defined and made decisions about overtraining. As we discuss further below, the research aligns with a growing body of coaching literature that acknowledges decision-making as complex, inherently subjective, and central to the interactive social process of coaching (Cassidy, Jones and Potrac, 2004; Jones, 2006, Jones *et al.*, 2011; Kidman *et al.*, 2005). While locating the work within the broad frame provided by sociological studies of coaching pedagogy, we also draw on the tenets of naturalistic decision making (NDM) (Lipshitz *et al.*, 2001, Klein, 2008). NDM provides clearer insights into the decision-making processes that the coaches engage in amidst complex and clearly demanding contexts in which expectations for continued international success are explicit and from a coaching perspective 'ever

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present'. ~~As an illustration of this expectation, over the period of the study two coaches with histories of international success were made redundant meaning they had to seek employment elsewhere because of poor performances.~~

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Optimal conditioning, overreaching and overtraining.

In pursuit of optimal performance training loads have increased dramatically which in turn has increased the risk of overtraining (Gould and Dieffenbach, 2002), something exacerbated by the often-used practice of implementing periods of excessive workloads (Urhausen & Kindermann, 2002, Meeusen *et al.*, 2013). While optimal conditioning requires a healthy athlete and an effective training programme that balances intensive training with adequate recovery, arguably the athlete who can continue to respond positively to the greatest training load will develop the best physical conditioning (Smith, Hopkins & Lowe, 2011). This creates more pressure for the coach who must find the ideal balance between the benefits and risks of intensive training. The research on overtraining has lead to some confusion around the definition and diagnostic criteria (Kreider *et al.*, 1998). ~~run on rather than break para~~ In response to this the European College of Sport Sciences formed a task force that has developed a position statement on the prevention, diagnosis and treatment of overtraining syndrome (Meeusen et al., 2006). An important part of this statement was defining overtraining as a verb, "a process of intensified training with possible outcomes of short-term overreaching (functional overreaching), extreme overreaching (non-functional overreaching) or overtraining syndrome" (Meeusen *et al.*, 2006, p. 2).

More recently The American College of Sports Medicine published a ~~a~~ similar consensus ~~joint~~ statement ~~was collaborated with The American College of Sports Medicine~~ (Meeusen et al., 2013) showing a fatigue continuum that results in performance changes ranging from increase, temporary decrease, stagnation and decrease (see Table 1). Non-functional overreaching and overtraining syndrome are the stage on the fatigue continuum where reduced performance is combined with the mal-adaptation of various physiological mechanisms. The differences between non-functional overreaching and overtraining syndrome are often subtle and based on a retrospective diagnosis on the period of performance reduction, plus prolonged mal-adaptation of several biological, neurochemical and hormonal regulation mechanisms.

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The prevalence and detrimental effects of overtraining in endurance athletes during hard training has stimulated a search for diagnostic markers that could predict its onset (Gleeson, 2002, Urhausen & Kindermann, 2002, Meeusen et al., 2013). An effective marker must be sensitive enough to predict impending overtraining enabling remedial reductions in training, and also be specific enough so that training is not reduced for an athlete who would benefit from the increased training overload (Smith, Hopkins & Lowe, 2011). This is clearly challenging, particularly when we also recognise that~~since~~ Fry *et al.* (1991) identified 84 major symptoms of overtraining and many other scholars have promoted a wide range of signs and symptoms of overtraining (e.g. Gleeson, 2002; Hartmann & Mester, 2000; Hooper *et al.*, 1995;~~,~~ Lehman & Foster, 1999; Meeusen et al., 2013; O'Toole, 1998;~~, Lehman & Foster, 1999, Hartmann & Mester, 2000, Gleeson, 2002,~~ Urhausen & Kindermann, 2002,~~ Meeusen et al., 2013~~). Kentta and Hassmen (1998; 2002) consequently proposed a novel athlete self monitoring system that attempted to address the physiological, psychological and social dimensions of training and recovery. This system consisted of the ratings of the perceived exertion (Borg, 1998) and the total quality recovery (Kentta & Hassmen, 1998, 2002) scales.

Despite such research

and the regular promotion of various markers as effective monitoring tools (Aldercreutz *et al.*, 1986; Barron, 1985;~~,~~ Gleeson, 2002;~~Aldercreutz *et al.*, 1986~~, Hartmann & Mester, 2000; Hooper *et al.*, 1995; Mackinnon, 2000; Morgan *et al.*, 1987; Meeusen et al., 2013; ~~, Hooper *et al.*, 1995,~~ Smith, 2000; Urhausen *et al.*, 1998~~, Hartmann & Mester, 2000, Mackinnon, 2000, Smith, 2000, Gleeson, 2002, Meeusen et al., 2013~~) ~~,~~ there is negligible evidence for a diagnostic marker that has the sensitivity and specificity to accurately predict impending overtraining (Halson, & Jeukendrup, 2004; Smith, Hopkins & Lowe, 2011). Furthermore, accurate diagnosis of overtraining can only be made retrospectively, after all other possible influences on performance have been excluded (Meeusen et al., 2013). Thus, during training and particularly

during periods of training when overload is maximised, the coach must constantly monitor the athlete so as to judge if recovery periods and/or training intensity need to be modified in response to signs of impending overtraining. The markers proposed to predict impending overtraining are objective and scientific, yet by its very nature coaching is arguably as much an art as a science (Woodman, 1993), more subjective than objective (Nash & Collins, 2006). Not only is the accuracy of the supposed markers of overtraining questionable (Halson & Jeukendrup, 2004), but the ability of the coach to utilize them effectively is questionable.

While publications reporting on strategies to detect and manage overtraining from the sport science and medicine fraternity abound (e.g. Gleeson, 2002; Meeusen *et al.*, 2006; Meeusen et al.,

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2013; O'Toole, 1998;, Gleeson, 2002, Urhausen & Kindermann, 2002, Meeusen *et al.*, 2006; Meeusen et al., 2013) very little attention has been accorded to coaches talking about the practice of successful coaching. From our anecdotal evidence we were intrigued by the potential discrepancy that existed between the strategies promoted by sport scientists such as (Meeusen et al., (2013) for predicting impending overtraining and those employed by successful coaches. This aroused our curiosity and consequently wWe therefore chose to look more closely at coaches' decision-making with a specific focus on overtraining in an elite performance environment.

Making decisions as a coach: The scientific and the subjective

The challenge for the coach, positioned at the nexus of a vast array of information when managing their athletes' training, is to decide what to act on and when. Moreover, hHow do they decide what strategies for monitoring their athletes, best complement their skill sets, knowledge, personality, while keeping in mind the environment in which they work–? The multitude of such considerations infers there is no simple strategy for monitoring overtraining and that methods employed by successful coaches working are quite possibly unique, changeable and unorthodox. It is evident readily apparent that not everything is clear-cut and there will always bethat some element of subjectivity when determining how this occurswill come into play. As indicated above, such a view aligns with conceptions of coaching as more of an art than science (Woodman, 1993), 'as pedagogy' and a complex and constantly changing social process (Jones, 2006). As argued by Lyle (2002) coaches must make decisions that are often based on experience, intuition and the fickle behaviours of athletes. Much of this knowledge is not situated within the scientific world, but rather the social. Coaches learning, decisions and actions reflect a dynamic between 'the scientific' (knowledge, understandings, principles and data) and 'the social'. The latter welcomes knowledge as grounded in personal experiences of coaches (see for example, Jones, 2006) and points to the value of a naturalistic approach to understanding and researching coaches' decision-making.

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Naturalistic decision making (NDM): A framework for exploring situated decisions

In essence we wanted to explore the transition from 'concept to context' and learn how these coaches actually made decisions about overtraining in a real-world or naturalistic setting, characterised by the need to make difficult and potentially 'high stakes' decisions often under demanding conditions. Naturalistic decision making (NDM) (Klein, 2008; Lipshitz *et al.*, 2001,

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~~Klein, 2008~~) emerged in the late 1980s and was adopted to explore the role of experience in enabling people to rapidly categorize situations to execute effective decisions in real world settings. It is a framework used by researchers in medicine (Elstein, 1978, Gawande, 2003) and business settings (Isenbcrg, 1984) where the stakes can be high, decisions often have to be made in conditions of limited time, and where decision-makers are forced to make a judgment call that may have very significant consequences for themselves and others. Field research by Klein and colleagues (Klein, 2003) highlighted that many formal standards of decision-making employed in training programmes did not improve decision quality and were basically discarded as cumbersome and irrelevant in field settings. NDM research therefore turned attention to the role of experience in decision-making, as opposed to individuals making choices from available options. ~~Focus was accorded to p~~Prior perception and recognition of situations were foregrounded, with Klein's work emphasising ~~the idea~~ that "when people need to make a decision they quickly match the situation to patterns they have learned" (Klein, 2008, p. 457) and if a clear match is made, they can follow a typical course of action. In sum, NDM has presented an option of *intuitive decision-making* (Klein, 1998; 2003, Myers, 2004).

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~~Arguably the most celebrated work that has examined intuitive judgement and decision-making is that of Nobel Prize winner Daniel Kahneman (Kahneman, 2003). His collaborative work with Amos Tversky (Kahneman & Tversky, 1984) is couched through three pertinent topics: heuristics and judgements, risky choice, and framing effects. All three topics focused heavily on intuitions based on thoughts and preferences that come to mind quickly and with little reflection.~~

~~Two generic modes; an intuitive mode (thoughts and preferences that come to mind quickly and without significant reflection) and a controlled mode that is deliberate and slower. These proposed topics later became accepted as a two-system view that distinguishes intuition from reasoning. System 1 is "fast, automatic, effortless, associative, implicit (not available to introspection), and often emotionally charged; they are also governed by habit and are therefore difficult to control or modify" (Kahneman, 2003, p. 698). System 2 operations are "slower, serial, effortful, more likely to be consciously monitored and deliberately controlled: they are relatively flexible and potentially rule-governed (Kahneman, 2003, p. 698). Kahneman explains that system 1 generates impressions of the attributes of objects of perception and thought. The label *intuitive* is applied to pronouncements that directly reflect impressions - they are not modified by system 2. By contrast *judgments* are always intentional and explicit whether they stem from impressions or reasoning.~~

Klein (2003) has argued that skilled decision makers often are more effective when they trust their intuitions than when they engage in detailed and systematic analysis. In contemporary contexts of elite performance coaching, it seems highly pertinent to explore this proposition and in

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so doing, extend insights into the ways in which the dynamic between scientific and subjective knowledge plays out in coaching pedagogy (Gilbert & Côté, 2013; Harvey, Lyle & Muir, 2015; Lyle & Vergeer, 2013). Following Cassidy *et al.* (2008) we recognise the prospective significance of the reflective process as a means of coaches extending their awareness of experience and meaning. While subjective knowledge connotes knowledge gained through personal experience, experience alone will not necessarily create knowledge. Experience must be reflected upon for it to become meaningful (Arnold, 1979). It is through a reflective process that coaches generate subjective knowledge whilst developing an enhanced understanding~~s~~ of aspects of training and performance, such as overtraining. This study provides insight into the subjective knowledge and subsequent actions of three elite rowing coaches with particular regard to overtraining.

The research context

Three experienced and highly successful professional coaches from the Rowing New Zealand elite team agreed to participate in this research. All had at least eight years experience coaching national representatives and collectively had coached nine Olympic medalists and 43 crews who had won medals at either Senior A or Senior B World Rowing Championships. As well as extensive coaching experience the coaches had also undertaken a number of coaching and sport science courses, with two having completed tertiary qualifications that included papers in sport science, sport psychology and coaching. The coaches also had extensive open access to a network of qualified and respected sport science and medicine specialists.

The project received ethical approval from a New Zealand University and all possible measures have been taken to protect the identities of the three coaches. We have therefore adopted a style of writing in the findings that balances the requirements of presenting the coaches views and beliefs while trying to reduce the speculation within or beyond the Rowing New Zealand community about 'who said what'. It is for this reason we have not allocated pseudonyms or assigned any contextual detail.

A series of three semi-structured, in-depth interviews were conducted with each coach, with interviews lasting between 20 minutes and 2 hours. In acknowledging the potential complexity of the respective coaching styles, each interview was guided by the schedule but followed its own pathway. This afforded flexibility to openly explore each coach'~~ses'~~ ~~individual~~ perspective on the issues being explored and to probe and extract~~plore~~ the multiple levels of discourse used.

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Moreover, this process ~~by the~~ facilitated~~allowing~~ a focus not only on the words spoken but also on the meanings intended (Wolcott, 1994).

The three interviews collectively addressed (i) how the coaches' defined overtraining, (ii) why they considered overtraining important and (iii) the cues they used to determine whether or not a rower was at risk of impending overtraining. Further details of the interview schedules are provided in Appendix 1. The first interview was conducted at the team's training base at a date and time convenient for ~~the respective~~each coach. The first and two f~~F~~ollow-up interviews were conducted at ~~various~~similar stages of the season ~~times and places where the team was located~~ over a ~~subsequent~~ period of three years, however questions to clarify interview transcripts were conducted whenever required. ~~This research method was deemed appropriate as it promoted the flexibility to probe and explore the multiple levels of discourse used by the allowing a focus not only on the words spoken but also on the meanings intended (Wolcott, 1994).~~

All of the interviews were conducted by one of the authors who was lead sport physiologist for this rowing programme. His research focused on examining a wide range of strategies for optimising performance and predicting overtraining for elite rowers as they prepared for international competition. He was imbedded fulltime with the New Zealand elite rowing team for five years. In this role he travelled with the team at every training venue and international competition that included World Rowing Championships and the Olympic Games. The interviewer's standing and trust through the years of shared experiences enabled extensive access to the coaches, something that for this study allowed an in-depth exploration of the motives and reasoning underpinning the coaches various practices employed by each coach.

~~The first interview was conducted at the team's training base at a date and time convenient for the respective coach. Follow-up interviews were conducted at various times and places where the team was located over a subsequent period of three years.~~ All of the interviews were digitally audio-recorded and transcribed verbatim. The coaches were provided with copies of their completed transcripts within a month of their interviews, which they signed to verify that they were an accurate record of their respective interviews.

Following transcription all interview data was inductively analysed using ethnographic content analysis (see Altheide, 1996, Saldana, 2009). This procedure facilitates a process that consciously avoids being too rule bound which can inhibit categories to emerge from the raw data/transcripts. Consequently, transcripts were analyzed using open coding (Gibbs, 2007), where the descriptive data were ordered for salient theoretical themes and/or issues that lay behind the text could be identified. Each transcript was read reflectively several times to promote and confirm the identification of key themes (Coffey & Atkinson, 1996). In addition, the coaches were also

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consulted individually and on a regular basis during the preparation of this manuscript. Any issues they had with our interpretation of their views were factored into this version the article.

Results and discussion

The analysis le~~a~~d to the identification of three themes in the data set (i) Personal - A coach's definition and description of overtraining (ii) risk and justification of intensive training regimes; and (iii) recognizing the signs of overtraining. ~~These~~ These themes highlight the salient considerations with regards to the decision-making process when ~~about~~ preparing ~~over-training and subsequently how these coaches considered this~~ the decision-making process ~~when preparing~~ their elite athletes for achieving in the high performance sporting arena. More specifically the data relating to these themes brings to the fore the centrality of non-scientific indicators and intuition in the decision-making processes that the coaches engaged in as they sought to maximise athletes' performance and ~~in~~ so doing ~~this~~, effectively mediate risks associated with overtraining.

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~~Results and discussion~~

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Personalised understandings: Coaches definition and description of overtraining

The coaches had spent many years working in the same sporting environment, something that had probably resulted in a shared philosophy on many aspects of coaching. It was therefore not surprising that their definitions for overtraining had a common theme, namely: training that caused excessive fatigue would lead to reduced performance. From their perspective, reduced performance was determined by an inability to maintain "normal" training workloads for an "extended" period of time despite the best intention of the rowers. An indicative perspective was

> ~~*They want to do it but they just can't go fast enough. They may talk about wanting to do well, they*~~ *They may keep training, but they are just well off the pace, they just fall behind, they can't do it.*

The coaches believed that as the rowers neared the end of an intensive period of training they should experience reductions in training performance~~,~~. All three coaches ~~a condition they all~~ considered this to be normal. They also explained, however, that these reductions should be acute,

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that is training and competition performance should return to normal after the programmed period of recovery, which typically lasts three to seven days. ÷

> *I 'd like to try and build a little more intensity into it week after week so come to that (final week of the training block), they should be smashed, They should be really smashed and as long as you're not getting massive changes in [(measures of training performance]), I think that's acceptable because they do bounce back ... and have great (performance results). We push them hard so that some weeks they are going to get fatigued and tired but tiredness and fatigue from just training is different than overtraining... There is a difference between fatigue and overtraining ... the difference for me is when I build them through a really hard week I expect them to be tired ... I expect them to be absolutely knackered for the last week of training, but that is what the plan is, if you have worked hard enough that is what happens, I think you've got to go a little bit past what they think they can handle to get more out of them. Day to day you are assessing how they cope with the workload in training. It's the standard thing, their [boat speed].*

Rowers whose performance failed to return to normal after these programmed rest periods were considered to be at risk of overtraining because '*they are coming back from their hardest week and after a break and their lightest week they are not recovering, they haven't bounced back'.* This coach verified his interpretation by stating '*they need to be out there doing the same amount of work holding the same [speeds] every day and if they can't for a long period of time ... then something's not right and we might back them off.'*

The risk of overtraining was seen as increasing as the period of time over which their performance had decreased extended, with the decrease generally determined from their training speeds. Furthermore these performance reductions were not the normal fade experienced during period of acute fatigue. They are very obvious and severe reductions:

> *Overtraining in the crudest sense of the word is when they have consistent [poor] performance ... noticeable decrements in performance ... we are not talking about the gradual fade that you might get across a training week or a training block, it's quite gross and obvious.*

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The Probing the coaches about their' views of overtraining were clarified after a series of follow up interviews culminating in the following consensus, that '*overtraining is a level of chronic fatigue that reduces training to the point where performance at upcoming international competitions is impaired*'. International competition performance could be impaired because of undue fatigue effecting race performance and / or reduced quality of training resulting in suboptimal conditioning. This definition is in essence subjective and individualized from a coaching perspective, as the level of performance decrease that signifies overtraining differs for each rower. The salience of subjectivity is perhaps best reflected in the view of one coach who argued '*I have had two athletes that were [theoretically] overtrained. They were continually tracking backwards for [2-3 months] but they were not properly overtrained because I don't think it ruined their [international] season.* In this instance the two rowers performance measured regularly during testing, training and competition slowly deteriorated over the 2-3 month period of training. The coach believed that while these two rowers were very fatigued during this training period this fatigue eventually dissipated and they subsequently performed well, hence they were not overtrained.

If we return to literature, it is clear that a single definition for overtraining from researchers and practitioners has proved difficult and that a wide range of definitions prevail (Halson & Jeukendrup, 2004; (Kreider *et al.*, 1998, Halson and Jeukendrup, 2004). Overtraining can be considered as prolonged maladaptation of athlete performance and various biological, endocrine, immune, neurochemical and metabolic regulation mechanisms (Meeusen et al., 2013). It is therefore not surprising that these coaches had developed their own definition, and that their definitions appeared to have few similarities to the European College of Sport Science' (Meeusen et al., 2013) position statement on overtraining (see table 1). Meeusen *et al.* (2006) and the coaches viewed reduced performance as the criterion determinant of overtraining, although the coaches discussed measuring performance during both training and competition. By comparison Meeusen *et al*. (2006) did not address how performance stagnation or reductions were determined. Meeusen *et al.* (2006) also proposed an overtraining continuum (see Table 1) with the diagnosis of overtraining dependent on the timeframe of performance reduction and the degree of physiological maladaptation and/or psychological disturbance. The coaches disagreed with both a set timeframe of performance reduction plus physiological and psychological factors being used to define overtraining. The disparity between the subjective and the scientific definitions for these two terms was perhaps best articulated by one coach who stated, '*I am not a subscriber to overtraining as it's laid out in the textbooks.*

The aforementioned disparity between the coaches definitions of overtraining and those presented by Meeusen *et al*. (2006) may relate to the different ways in which coaches and sport

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science or medical practitioners respectively conceptualise overtraining. While the coaches appear to view overtraining through a subjective lens, the sport science and medical practitioners are more likely to employ a scientific perspective that has thus far failed to determine a common definition and effective diagnostic tools (Budgett *et al.*, 2000, Halson and Jeukendrup, 2004). This incongruence has led these three coaches to ignore the lexicon of scientific terminology. The coaches were unaware of the terms non-~~functional~~ functional, overreaching and overtraining syndrome. ~~The disparity between the subjective and the scientific definitions for these two terms was perhaps best articulated by one coach who stated~~insisted, ~~'*I am not a subscriber to overtraining as it's laid out in the textbooks.'*~~

While many of the published definitions of overtraining focus on reduced performance the coaches believed that sport science and medical practitioners defined and determined overtraining from tests of physiological maladaption and/or psychological disorders. This may reflect that the various sport scientists and sport physicians they have come in contact with have been seen to use solely physiological and/or psychological assessments to diagnose overtraining. One coach described an incident when one of his better athletes had been diagnosed as overtrained by a sport physician:

> *[Athlete] had gone to the [Sport Physician] because he said he wasn't feeling well. [The Sport Physician] told him he was overtrained and that he needed time off. [Athlete] was rowing well and doing good numbers (training speeds)… We carried on as normal and he went on to [perform with distinction].*

In this instance there were no abnormalities in the blood tests or physical assessments, the diagnosis was made solely on the basis of psychological assessments of mood, quality of sleep and perceptions of fatigue. The coach expressed his displeasure at this process and believed that he had information relevant to the diagnosis. Another coach described an incident where a medical practitioner gave an athlete that he considered as overtrained a clean bill of health recalling '*I remember one guy who had a blood test... there was nothing wrong with his blood test, but he was just down and he never came back up, he was overtrained and never recovered.'*

The inclusion of physiological maladaptation and psychological disturbance in the scientific definition of overtraining is common and these measures are commonly referred to as signs and

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symptoms of overtraining (Gleeson, 2002; Hartmann and Mester, 2000; Meeusen et al., 2013; O'Toole, 1998; ~~Hartmann and Mester, 2000, Gleeson, 2002,~~ Urhausen and Kindermann, 2002, ~~Meeusen et al., 2013~~). We believe that logistical and technical difficulties in accurately assessing change in performance (Hopkins, 1991) has forced many sport scientists and physicians to utilise physiological and psychological signs and symptoms of overtraining as proxies for both defining and detecting overtraining. There is, however, little evidence to support the notion that abnormal changes or levels of one or more physiological and/or psychological marker, reliably predicts chronic reductions in sporting performance (Halson and Jeukendrup, 2004).

~~The disparity between the subjective and the scientific definitions for these two terms was perhaps best articulated by one coach who stated, '*I am not a subscriber to overtraining as it's laid out in the textbooks.*'~~

There are many possible reasons for the differences in the definition employed by the coaches compared to those of Meeusen *et al.* (2006, 2013). We believe one of the major reasons is that the coaches definition is based on performance, as this is the area they understand, have some control over and is very important since the fastest endurance athlete is most likely to be successful. Hence their definition is pragmatic and focuses on *subjective interpretation of measures of performance*. ~~On the other hand t~~The definition proposed by Meeusen *et al.* (2006, 2013) focuses not only on the objective measures of performance but also those causal mechanisms that can be objectively quantified, which is a key tenet of the scientific method. ~~The problem with this approach is~~As Halson and Jeukendrup (2004) have observed, however, ~~–~~the relationship between the criterion measure (performance) and the various proposed causal mechanisms determined by various physiological and/or psychological measures, is usually poor ~~(Halson & Jeukendrup, 2004)~~, which should invalidate their inclusion in the definition and description of overtraining.

Risk and justification of intensive training regimes

Overtraining is considered to be more prevalent when endurance athletes are involved in periods of intensive training with reduced opportunity for effective recovery (O'Toole, 1998). All the coaches held strong beliefs on the importance of training beyond the athlete's tolerance for prolonged periods, as a means of extending their physiological and psychological capacities. They believed that what differentiated success from failure in international competition came down to small fractions of a percent advantage in speed over their competitors. Therefore, optimising athletes' performance capabilities was vital for success and this was only achieved through periods of intensive training. ~~Hence~~ Consequently, all three coaches considered overtraining to be an ever-present and legitimate risk, due to the intensity of their respective programmes. One coach

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~~exclaimed:~~explained the pressure~~s~~ to train not only as hard, but harder than the opposition, saying that;

> ~~*You've got to train hard, harder than anyone else and there are so many examples out there that you have to train harder than the opposition [to beat them], if you don't train as hard as, or harder, then you're not going to beat them.*~~ *There are always going to be crews that are going to beat you that are exceptional, but on a level playing field if you don't train as hard or harder than them, you are not going to win.*

Inevitably, pushing the training boundaries in this way, carries the risk of overtraining, but is seen as necessary in order for crews to achieve the highest levels of success internationally. Another coach ~~who described his international competition further qualified this perspective by asserting~~reaffirmed this stance ~~*'they're [successful because they] have enough physiological specimens who can race bloody well, but aren't necessarily that fit and trained that hard, if we can train harder, we can beat a lot of those countries.'*~~

~~Advocacy for the emphasis on the importance of hard training was reflected in another coach~~:

> *I expect them to be absolutely knackered for the last week [of the block of training]… that is what the plan is, if you have worked hard enough that is what happens. I think you've got to be careful not to cut back [the training load] too early… you've got to go a little bit past what they think they can handle to get more out of them.*

These quotes reflect that the coaches' focus was on trying to train athletes beyond what they believe they are capable of and in the process, reset the athlete's perceptions of what their bodies can handle. All the coaches spoke about gradually increasing the workload over a period of 3-5 weeks so that at the end of this period the athlete could not adequately recover, resulting in severe fatigue and performance reductions. This was followed by a taper, that consisted of a period of reduced workload, and rest that should stimulate a super-compensatory response thereby creating enhanced physical adaptations. This process of intensified training overload creating acute fatigue is an often-used method for stimulating adaptations in high performance endurance athletes (Bompa, 1999, Bompa and Carrera, 1999). The coaches all considered this process to be important for the development of their athletes but were ~~however,~~ also cognisant that it dramatically increased the

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chances of the athlete not recovering in the available timeframe, thus increasing the risk of overtraining:

> *When you are working with elites and you're trying to push, really push them along and get those fractions of a percent, you are on the knife edge it would be very easy for it to go either way…. it's a fine line probably between training in what they would call an overtrained state and actually overtraining and tipping them over.*

> *If they're not slightly over the edge then perhaps they're not pushing the boundary of their limits enough". "You almost have to have someone [almost overtrained] or else you're not quite pushing them hard enough. This is what they've got to do as an elite rower, … if they don't do it they're not going to race to the best of their ability anyway.*

> *You've got to push it to the limit, you don't know what the limit is so you've got to push, it's better to push up there and take a day off and recover than never to get there at all.*

Although there were only a few occurrences of overtraining suffered by rowers under their care, these three coaches described numerous incidences when their athletes had been on a "knife edge" and were acknowledged as very close to becoming overtrained. All of these incidences occurred during blocks of intensive training, but the coaches were unable to shed light on the possible reasons why at these specific times, the rowers fatigue had developed to the point that they were on the cusp of overtraining. The first incident occurred early in the training year, during a period of intensive aerobic conditioning. ~~The coach was alerted initially by the crews' training pace becoming erratic and from changes in their body language, and later from communication with the rowers.~~ He recollected *'they'd got to the level where they were just overworking … we were overworking them … we cut the miles down because [the athlete] was starting to row badly'.* The next two incidences occurred near the end of an intensive period of anaerobic conditioning just prior to competition at the World Championships:

> *We were lucky that year we probably pushed them over the edge, fortunately the (weather) kept us off the water for a while and it allowed them to come back up again … it was very close.*

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Oh yeah, we've pushed them pretty hard ... I remember [Athlete] saying 'I don't think we're going to survive this' ... it was pretty close to tipping them over.

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~~Once again, coaches became aware of the danger by monitoring training performance, interpreting body language and from communication with the rowers. The ways in which each of these factors informed coaches' thinking and decision-making is discussed further in the next section).~~

~~The following case was not a specific incident, but relates~~In another instance, one of the coaches gave an insight into how individualised their understanding of training and over training needed to be. Talking about ~~to~~ a rower who was recognised as having a habit of training extremely hard all of the time, and was perceived to be constantly in danger of overtraining and/or injury, he explained:

[Athlete] works bloody hard just to hang on and you could easily tip [them] over, [they've] just got to keep on going, yet [Athlete] managed to hold on for the last 3 to 4 years and [has] improved because of it.

~~.~~ The coach explained how constant monitoring of the body language and performance of this rower often revealed episodes of extreme fatigue, which needed to be managed to reduce the risk of overtraining. ~~:~~

The challenge ~~for each coach was to~~of ensure~~e~~ing that the rowers completed the required periods of intensive training while at the same time managing the concomitant risk of overtraining. ~~This challenge~~ was exacerbated by the fact that the coaches would often have to monitor the response of the individual within a crew of two, four or eight rowers. It is therefore possible that the same training programme can result in a mixture of under, optimal and over training for the individual rowers within the same crew. One coach explained that:

[Athlete] is a genuine case of overtraining ... which goes to the individuality of training doesn't it? ~~-~~ where as we train everyone the same, someone like [Athlete] obviously can't, physically probably handle that volume of work, somehow you've got to do something different with [Athlete], which is hard in a crew.

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~~*[Athlete] works bloody hard just to hang on and you could easily tip [them] over, [they've] just got to keep on going, yet [Athlete] managed to hold on for the last 3 to 4 years and [has] improved because of it.*~~

The coaches were also aware of times when they had pushed the boundaries and their rowers required extended periods of recovery to halt the deterioration of their performance. A good example of this is described thus:

> *We had to back him right off and just really keep him out of the boat for three to four weeks, and if we hadn't … he wouldn't have bounced back at all … but it was always touch and go.*

Collectively the coaches had achieved numerous international successes that they believed confirmed the effectiveness of their intensive training regimes, despite the increased risk of overtraining. Their view was that if an athlete could not follow their respective programmes in the early stages of the training year they would not be competitive internationally. Therefore, any athlete who struggled to handle the training load, especially during the early "easier" portions of the programme was probably unlikely to succeed and retain their position in the team explaining *'they're coming into the elite programme so they're expected to be able to do it. It's the old story, if they can't do it perhaps they shouldn't be there anyway.'*

~~The coaches made the rowers aware that they required a large volume of intensive endurance training in an extremely competitive environment. The challenge for each coach was to ensure that the rowers completed the required periods of intensive training while at the same time managing the concomitant risk of overtraining. This challenge was exacerbated by the fact that the coaches would often have to monitor the response of the individual within a crew of two, four or eight rowers. It is therefore possible that the same training programme can result in a mixture of under, optimal and over training for the individual rowers within the same crew.~~

~~*[Athlete] is a genuine case of overtraining … which goes to the individuality of training doesn't it, where as we train everyone the same, someone like [Athlete] obviously can't, physically probably handle that volume of work, somehow you've got to do something different with [Athlete], which is hard in a crew.*~~

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Further factors to consider ~~here~~ in understanding the coaches' approaches are that the coaches are working with a very limited pool of athletes and that the continued funding of the programme, and their ongoing employment as coaches was reliant upon maintaining success at the international level. The coaches were also aware, however, that arguably 'risky practices' in terms of the level of risk of overtraining, were an integral component of Rowing New Zealand's international successes:

> *They're coming into the elite programme so there expected to be able to do it. The old story if they can't do it perhaps they shouldn't be there anyway. You almost have to have someone breaking down or else you're not quite pushing them hard enough, so I expect them to go out and do it because they're the elite, this is what they've got to do as an elite rower, get that volume of work done. If they don't do it they're not going to race to the best of their ability anyway, You can't hold the whole crew back for one person, you can't hold the whole programme back for one person, you've got to push …. so if we wrote off the whole programme [almost all became overtrained] to get that one person who could do the work, that would give us a gold medal, whereas if we focused on the bottom level we'd never get a gold medal.*

While this ~~Darwinian~~ approach ~~to training~~ can ~~sound~~ appear harsh, as indicated above, it has reaped many rewards for New Zealand rowing. Nevertheless, ~~despite this success and the associated promotion of intensive training,~~ the coaches believed that *constant vigilance for overtraining cues was an important aspect of their coaching roles*. It should be noted that rowing is typically a crew sport and the crews are assigned to the coach by the selection panel. The crew is unlikely to be successful if all members are not healthy, therefore while these coaches acknowledge intensive training as an important component of success, allowing a weaker crew member to become overtrained is counterproductive.

~~Although we have considered if these practices are the best for optimising athlete performance or whether there are better, possibly more "humane" ways of developing a successful international rower, again, we have been promoted to acknowledge some unique characteristics of this coaching context. The athletes are volunteers with generally limited financial support who stay in the programme for a number of reasons that include the achievement of their goals. The numbers of elite New Zealand rowers has risen approximately four-fold from 2000-2010 compared to the previous decade, with the numbers of rowers winning World Championship and Olympic medals increasing approximately ten-fold for the same period. Arguably, if the rowers did not support the~~

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~~coaches' intensive approach to training, their numbers and successes would have declined during the tenure of these coaches.~~

~~As indicated above, the most important criterion for the on-going employment of these coaches is continued international success. Their success is evident in their previously mentioned medal counts and the fact that the RNZ elite programme has enjoyed a world ranking of 2nd to 3rd over the last four years while their ranking was only ~25th in the late 1990's. Therefore, while there may be more effective training strategies than those employed by these coaches, their methods have arguably been very successful.~~

The coaches all cared for their rowers' wellbeing, but at the same time they were aware that implementing intensive training regimes that increased the risk of overtraining also increased the chance of the rower realising their goal of success. ~~The coaches'~~ These sentiments are borne out in the following ~~-~~comment:

> *I definitely have a genuine concern for my rowers, I think it's probably a flaw and I had to be a little more ruthless but I was just of the opinion that you know we're trying to get a [boat] to go fast and we need the psychologically, physiologically, whatever, strongest people sitting in that boat*

The coaches were therefore, committed to maintaining a programme that they acknowledged, carried inherent risks and challenges in terms of managing athletes during periods where they are on the knife-edge of optimal training versus overtraining. Being effective in this context centres on coaches' ability to recognise and respond to signs of overtraining.

Recognising the signs of overtraining

The challenge for the coaches was to determine what useful tools and strategies could help them to manage the heightened risk of overtraining. As indicated previously, this challenge was accentuated by the dominance of objective scientific methodologies that have thus far failed to produce reliable and valid predictors of overtraining (~~(~~Halson, 2004; Meeusen, 2006, 2013). Hence, as we now illustrate, the coaches' focus is 'performance reduction' and they have developed *subjective strategies to predict impending overtraining*.

The most important marker or cue of increased risk of overtraining for all three coaches was *performance reduction*, recognition of which was reliant on *performance monitoring*. While these terms may be seen to imply or align with scientific discourses, this research revealed the extent to which in this elite and applied context, subjective discourses necessarily came to the fore in

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coaches' descriptions of the ways in which they gain an understanding of the rowers' performance, responses to training, and risks of overtraining.

Competition is often regarded as the best monitoring tool for determining changes in performance. It is, however, rare for elite rowers to have regular competition, with consistent environmental conditions and the same competitors competing maximally. Training workload is another common performance monitoring tool, however logistical and technical difficulties have resulted in a lack of valid and reliable measures of training performance for most endurance sports (Hopkins, 1991). In monitoring performance the coaches measured boat speed for most training sessions, implemented weekly competition sessions over various distances and raced in a regatta at least once a month. These performance-monitoring strategies only measured the speed of the boat and not the individual members of the crew, unless the rower was a single sculler. For this reason the coaches regularly added competitive rowing ergometry sessions and/or training in the smaller boats (singles and coxless pairs) to enable more effective monitoring of the individual rower. The importance and complexity of performance monitoring is reflected in the following coaches' comments:

> *It comes down to performance. If they had come and said to me oh you know look I'm [really tired] I'd go back and say look at this, you're ok, the numbers are still good, ... the boat speed's still there, we're at a point in the training programme when you should be feeling like this:*

> *You're always watching your rowers, just general mood and things like that, you're always keeping an eye on them but it's all quantified off the [boat speed and rowing ergometer] numbers that you collect.*

> *Well actually the [unit for measuring boat speed] is a good one because I mean that's an invaluable tool really. I think that's just the best thing that we've had access to. If the numbers on the U2 (aerobic base) you know [boat speed] are not where they're supposed to be, you know, and they've been holding the right [boat speeds] for a long time and then suddenly it just goes down for a while then I have to look at them and see what's going on physically.*

Performance monitoring in rowing is not a simplistic process because changing environmental conditions between and within a session can dramatically modify the boat speed. For this reason

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the coaches spoke about not just concentrating on absolute speed but also examining their crews' speed relative to the remainder of their squad and the team:

> *If you have two crews going against each other then it becomes pretty obvious one crew suddenly really drops its bundle. That's pretty easy to do.*

> *If you've got two crews it's easier you know if the boats are neck and neck and then one just drops right off the back.*

The challenge was determining the degree and timeframe of absolute and/or relative boat speed reductions and/or reductions in rowing ergometry that predicted upcoming overtraining. All three coaches expected some performance drop off during the week and possibly near the end of the 3-5 week training block. Their problem was determining what level of training performance drop off is considered abnormal and therefore a cue for impending overtraining. While they all made a number of comments on this issue, none were able to offer any heuristic for recognising impending overtraining. Such a drop off was acknowledged in one coach's description of an early cue for possible overtraining;

> *They have consistent [poor] performance over 2 or 3 sessions, a noticeable decrement in performance over 2 or 3 sessions, we are not talking that gradual fade that you might get across a training week or even across a training block, its quite gross and obvious.*

While dramatic reductions in training speed is an important cue for impending overtraining the more important consideration was the potential underpinning reasons for such a reduction. For example, a possible reason could be nutrition:

> *But what would be the level of falling off? You know a few metres, ~~fifty~~ 50 metres, 100 metres if they dropped off, 500 you know it could be just purely a lack of energy and food you know on the day.*

Another consideration could be the difference in how the individual rowers approached training and competition. While the coaches considered most of their rowers to be honest hard workers who followed the training programme to the best of their ability and competed maximally in all competitions, they described others as lazy trainers or inconsistent competitors:

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> *You need to be careful because some people don't put the effort in earlier on, they'll save themselves for the last one then you've got to juggle you know you might have to do another couple or something or you don't tell them what you're doing and try and get the work out of them ... Knowing what they're like, whether they're hard workers or a bit scared at the beginning or saving themselves for the last one you can understand those people.*

> *[Athlete] is not competitive enough day in day out [Athlete] would just do the same, same, same not worry about [trying to do faster speeds] every day ... and then believe that [they] could [race successively] on the day.*

Thus, it was important for the coach to develop an understanding of how individual athletes approached training to help them understand the possible reasons for poor performances. Whether *performance reduction* was a potential sign of impending overtraining, rather than being due to the considerations mentioned above, was achieved primarily through the coaches' experience, intuition, communication and observation of a rower.

> *They're your battle-hardened sort of warrior-type athletes, and so when they started falling over it was like you know maybe we need to change.*

> *Knowing what they're like, whether they're hard workers or a bit scared at the beginning or saving themselves for the last one you can understand those people.*

Communication was also considered an important cue for impending overtraining and was usually assessed in combination with the performance measures and observational strategies. Two of the coaches spoke at length about the importance of communication to determine the rowers' level of fatigue and performance reduction. Both sought regular feedback and created an environment where rowers and coaches communicated openly:

> *I see myself more as being like a facilitator than a coach, so yeah I reckon athlete feedback is crucial, it's how I coach, it's just me, I like to know, I like to get the athletes' input.*

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> *Well I just talk to them, I say how did that piece feel or how did that session feel … I know how it looked, how did it feel … tell me how you thought [it went] and I can tell you what I saw, and so we have interaction in that way.*

Communication with the athlete focused on a variety of issues that included whether fatigue was "excessive" and if so, their perceptions of why this was so. The coaches spoke of asking directly about the rowers' fatigue but also seeking to determine their mood to gain a better insight into the level of fatigue because '*mood affects the way you act so I think it's a hard one to pick really, you know sometimes you can see it, sometimes you can't, but hopefully if you can see it you try and help them change.'* If the rowers' fatigue was "excessive" the coaches spoke of trying to determine whether they were following proper nutrition, hydration, preparatory and recovery processes plus whether they were feeling healthy.

One coach was keen for the athletes to initiate communication with him, but did not proactively communicate with the athletes to determine the level of fatigue they were experiencing during training. He believed that the reason for this stance was that the intensive approach to training meant that that the athletes were often expected to be fatigued. He went as far as to suggest that if they were not heavily fatigued then they were probably not training properly. Hence when asked about fatigue a rower would usually reply that they were fatigued, which in his view provided few useful insights into how to manage the programme. Moreover, he did not think it productive to have the athletes engage in discussions about their level of fatigue:

> *The trouble is if you [initiate communication with the rowers] it can start influencing what you do. You know, they're always going to be tired and if you really ask them then you start reducing your training all the time and your programme wouldn't get any momentum.*

> *If you ask them, they're always going to be tired, they always have to be tired. If you've got someone who's got an injury if you go and ask them they'll tell you about the injury you know, you almost want them to forget about it and move on. Don't think of the pink elephant you know and you think of a pink elephant, how are you feeling, well I'm not feeling good now you come to mention it.*

All coaches acknowledged that opening the lines of communication with their rowers could increase their vulnerability to athlete manipulation. Their major concern was a rower accentuating

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their fatigue as a questionable means of reducing training load. As one coach confessed *I'm probably a bit more savvy now, I know, I can tell if a rower is having me on.*

The coaches described the need to balance what they heard versus their observations of the athletes and their performance measures to determine whether the athletes were being honest:

> *If someone says they're feeling a little bit [tired], if the speed [has not decreased below normal], well that's bad luck, we'll keep going, but if the speed's really starting to get affected then yeah you button off. So it's a combination of [communication and performance] and you get to know your athletes as a consequence of that. You can tell they'll test you out and when you've got the numbers there to back it up it's pretty easy to tell when … they're trying to have you on.*

Observation of the athletes was considered important for determining whether a rower was suffering severe fatigue and at risk of overtraining. The most important observational tool identified by the coaches was the athlete's body language, viewed prior to, during and after training. The coaches described several manifestations of body language including facial expression, how they carried themselves, their demeanour and how they sat or moved in the boat.

The coaches openly described the value of recognising the subtleties of body language. However, recognition could often be problematic and the different coaches tended to concentrate on selected aspects of body language:

> *It would just be looking at them, how they're going really. Look in the eyes, the face, the demeanour, the body language. A good coach, … should be there early enough to see them when they arrive and then you get a fair idea of how tired they are, how they carry the boat down to the pontoon will tell you pretty much where you want to be at. But being a top-class athlete is about being tired all the time. You can't be fresh.*

> *So they're coming up and you're looking at their demeanour and they're tired, sometimes you're thinking they're tired but they can handle it. But there comes that crucial time … and you're making the decision that they can't handle it.*

> *You look at the person and they actually look [different] and you look at them again and think, I never knew they looked like that. They actually look different you know. I*

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remember looking at [Athlete] and I looked at her again I thought 'oh' and the facial look is totally different and then you know [it was time to] give them three days off [because] I felt I'd driven them down to the point [of overtraining].

You can see the way they sit in the boat some days they might be slumping in a way they never do or they might be looking lethargic or slow and that's little indicators to me physically that things maybe they're not on top of their game today.

Even though body language was considered important it was also considered important to balance what you saw with the performance numbers. As one coach observed '*you're always watching your rowers, just general mood and things like that you're always keeping an eye on them but it's all quantified against the [boat speeds and rowing ergometer speeds] that you collect.'*

Another observational strategy described by only one coach was changes in their rowing technique that occurred when they became fatigued. Prolonged periods of poor technique were described as a possible indicator of impending overtraining. The other two coaches didn't agree with this approach and proposed that as the rowers were all elite it was very difficult to see any fatigue related changes in technique. After further discussions with this coach it is our belief that he was talking about efficiency determined by a combination of body language and boat speed. Hence while there may have been some small changes in technique the major change in the fatigued rower was that they looked less efficient, that is they looked to be putting more effort into maintaining their normal boat speed:

Sometimes you might have the speed there but if they look like they're just working real hard to get their speed so there's things like that what's going on there it doesn't look that bad but they look like they're just working [really hard] so facial expression and that sort of thing. Then you know again it's so easy on the water because you can see the boat speed and you can tell that they've dropped off.

They're holding the same speed but they're just working harder, but technically working worse, because [they are] trying to muscle it.

Observation was considered an important tool by all the coaches with one coach going so far as to suggest that the body language of the rower is the most important cue for impending overtraining. The coaches spoke about observation being used to assess the level of their athletes' fatigue

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through changes in body language, movement patterns, reaction speed, posture, facial expression, demeanour, mood, concentration and stress. These largely external indicators collectively present quite a contrast to the largely internal physiological indicators espoused by Meeusen *et al.* (2006, 2013).

Furthermore, the timeframe that the coach has to make a decision about whether to maintain or reduce the training load compounds the difficulty that coaches face in assessing the risk of overtraining. ~~run on~~ The coaches acknowledged the difficulty in assessing the point at which the rower was in danger of impending overtraining. This difficulty is highlighted by one of the coaches who stated:

> *Well I wouldn't just go training for the sake of it. If we went out on the water and I figured it just wasn't going to go then no we wouldn't do it. If it's got to the stage where they were too tired then it's no use flogging a dead horse. But picking that time especially at our level is almost nearly impossible.*

Each of the coaches was effectively endeavouring to process and inter-relate information from these sources in order to determine when the threshold for impending overtraining had been reached. The over-riding impression from the data is that there are no straightforward rules or a simple formula to inform the decision. Rather the coaches must necessarily rely on their subjective interpretation of the information that they receive for each rower. That information comprises quantitative performance data and qualitative data from conversations and observations.

Conclusion: Understanding high-performance coaches as intuitive and skilled decision-makers

Lyle (2002), requested that "[f]ar greater attention is required to be paid to the coach's cognitive processes. ...Performance enhancement research cannot be complete without attention to the coach's application, integration and delivery of knowledge" (p. 303-304). This research has sought to respond by exploring in depth coaches' understandings of overtraining and the complex decision-making processes associated with mediating overtraining as an ongoing and integral part of coaching in high-performance settings. Our data has identified that coaches' decisions about overtraining were based heavily on their subjective knowledge but that the decision-making process they employed included multiple markers to support a perspective of self-consistency. Through the

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accumulation and processing of these markers each coach was able to express their confidence in their decisions. There was not a propensity toward a specific marker but rather each coach participated in a search for supporting and inter-related elements, taking into consideration the unique context and individual athlete. The three coaches believed intensive training was essential for success and that this practice increased the risk of overtraining. They relied on changes in performance, observation and often communication together with knowledge of the rower to determine cues for overtraining. Their d~~D~~ecision-making was highly situated and intuitive. No defined measurement tools were employed, rather they favoured subjective appraisal to ascertain the point at which overtraining was imminent and an appropriate decision would be made. Each coach had his own unique approach depending on the rower, the environment and the stage of the training programme. Each approach required the processing of numerous sources of information and any proposed changes weighed up the risks versus benefits of maintaining or reducing the training overload.

The decision-making process also needs to be positioned and understood in the specific high-stakes contexts in which the coaches were working, with overt pressure for continued success created from their achievements in elevating rowing to New Zealand's top Olympic sport. This success led to an increased public profile and greater funding, which in turn resulted in greater numbers of rowers, coaches and support staff all requiring continued success to maintain their positions. The coaches' decisions on how to manage their athletes during the periods of intensive training were often made against a backdrop of athlete, sport code and national expectation, thereby exacerbating an already high-pressure situation. We believe this investigation highlights how a successful coach requires a vast amount of experience and confidence to support what would arguably be a highly intuitive decision.

A comparison of the strategies used by these coaches with the signs and symptoms of overtraining (Fry *et al.*, 1991, Kentta & ~~and~~ Hassmen, 2002, Meeusen et al., 2013) show more differences than similarities or agreement. Agreement existed around decreased performance being the criterion determinant for overtraining. The area of similarity is that some of the psychological variables mentioned in the literature such as demeanour, mood, lethargy, fatigue, recovery, concentration and stress (Fry *et al.*, 1991, Hooper *et al.*, 1995, Kellmann, 2002, Kentta &~~and~~ Hassmen, 2002) are similar to those mentioned by the coaches. However, while various inventories are recommended to assess these psychological variables, the coaches clearly relied on relatively unstructured techniques namely verbal communication and/or observation. There were acknowledged disparities in the terminologies to describe overtraining, the methods for determining

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decreases in performance and the degree of performance decrease that defines overtraining. Another area of difference is the many physiological, immunological, biochemical and psychological signs and symptoms of overtraining, which were largely disregarded by these coaches.

Kennta and Hassmen (2002) discussed the importance of monitoring perceptions of both fatigue and recovery as a method of understanding the rowers psychological, social and physiological stress levels. Despite much probing the coaches were reticent about discussing issues related to psychosocial stressors, especially those that originated outside the training or competition environs. The reasons for this remain unclear but we speculate that it is a deliberate tactic, as the coaches do not wish to be perceived as encroaching into their rower's personal lives. Yet throughout the interviews the coaches showed that they were often aware that issues in the rower's personal lives exacerbated their stress levels and effected performance. We believe this important and often-overlooked area requires further examination.

We would argue that the apparent lack of any objective diagnostic marker that accurately predicts impending overtraining (Halson & ~~and~~ Jeukendrup, 2004, Meeusen et al., 2013) has promoted the adoption of various subjective strategies by these coaches. It is more likely that the coaches have selected strategies they understand, are comfortable with, fit their coaching personalities and most importantly, have control over (Collins, Collins & Carson, 2016). Furthermore, predicting the point where normal acute fatigue becomes chronic excessive fatigue or overtraining is possibly too subtle and individualistic to ever be determined using scientific measurements alone. Although two of the coaches have tertiary qualifications that include sport science, all three suggested that *the management of athletes during hard training is more of an art than a science*. This perspective is best illustrated through the following reflective comments:

> *There is a real art in managing it as opposed to being completely reliant on the science, I think the science substantiates it and gives you a lot of what you need but in terms of really managing it and getting the most out of your athletes … the art side of it is more important.*

> *Yeah well you're either a scientific coach or you're an intuitive coach, an arty-farty type coach, science, art, one way or another. Either way … I guess I'm more that way ... intuitive, arty.*

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Despite such assertions there is negligible literature on the art of managing athletes against overtraining while the scientific and medical literature abounds. While this study has focused on decision-making by a small group of coaches in one selected sport, there is a need to further investigate how sport coaches make decisions across various codes and levels. It is also recommended that future research provides selected coaches with the opportunity to reflect on their decision-making practices and how such decisions are informed. Clearly many conceptual aspects of the coaching process must be positioned beside the personal attributes and attitudes of coaches. This investigation has highlighted how coach decision-making is strongly influenced by a subjective process, a process that to this point has sat in the too hard basket for too long (Polanyi, 1962). Moreover, the study has indicated that the adoption of NDM as a tool to investigate decision-making in a sporting context holds considerable potential.

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Table 1. Possible presentation of the different stages of overreaching and overtraining

PROCESS	TRAINING (overload)	INTENSIFIED TRAINING →		
OUTCOME	Acute Fatigue	Functional overreaching	Non-functional overreaching	Overtraining syndrome
RECOVERY	Day (s)	Days - weeks	Weeks – Months	Months - …
PERFORMANCE	Increase	Acute decrease (e.g. training camp)	Chronic stagnation or decrease	Decrease

Adapted from Meeusen et al. (2013).

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Appendices

Interview guidelines

INITIAL INTERVIEW

Background questions

These included personal details, experience, achievements and influences, philosophical understanding and positioning e.g.

- What is your personal philosophy and practices around physical conditioning, beliefs and influences?- How does the NZ rowing principles guide or differ from your principles?
- What is goal of your physical conditioning practices and why is this important in this coaching environment?-

Questions around defining over training and over reaching e.g.

- What do you believe "overtraining" (and over-reaching) to be and why?-
- What and who influenced your understanding of this term?-

Questions around the significance of overtraining e.g.

- Is overtraining an important issue for you. Aim to probe the link between the requirement for hard training to optimise conditioning and the concomitant risk of overtraining?-
- Why is this issue important / not important to you?- What and/or who has influenced your opinions on this?-

Questions around cues used to determine whether a rower~~s~~ was at risk from overtraining e.g.

- How do you monitor for "overtraining/over-reaching/excessive fatigue", why do you employ these techniques and why do you believe these monitoring tools are effective?-
- Can you talk about your specific experience/s with rower/s you've trained who have become overtrained.

FOLLOW UP INTERVIEW/S

Questions promoting reflection since initial interviews e.g.

- What methods and processes did you use to monitor overtraining or over reaching– please include all strategies e.g. perceptions, beliefs, social factors, body language, training workloads, performance data, medical information, physiological measures, etc?-
- If you implemented any changes were they successful and how did you determine there success?
- If you implemented any changes were they successful and how did you determine their success?

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