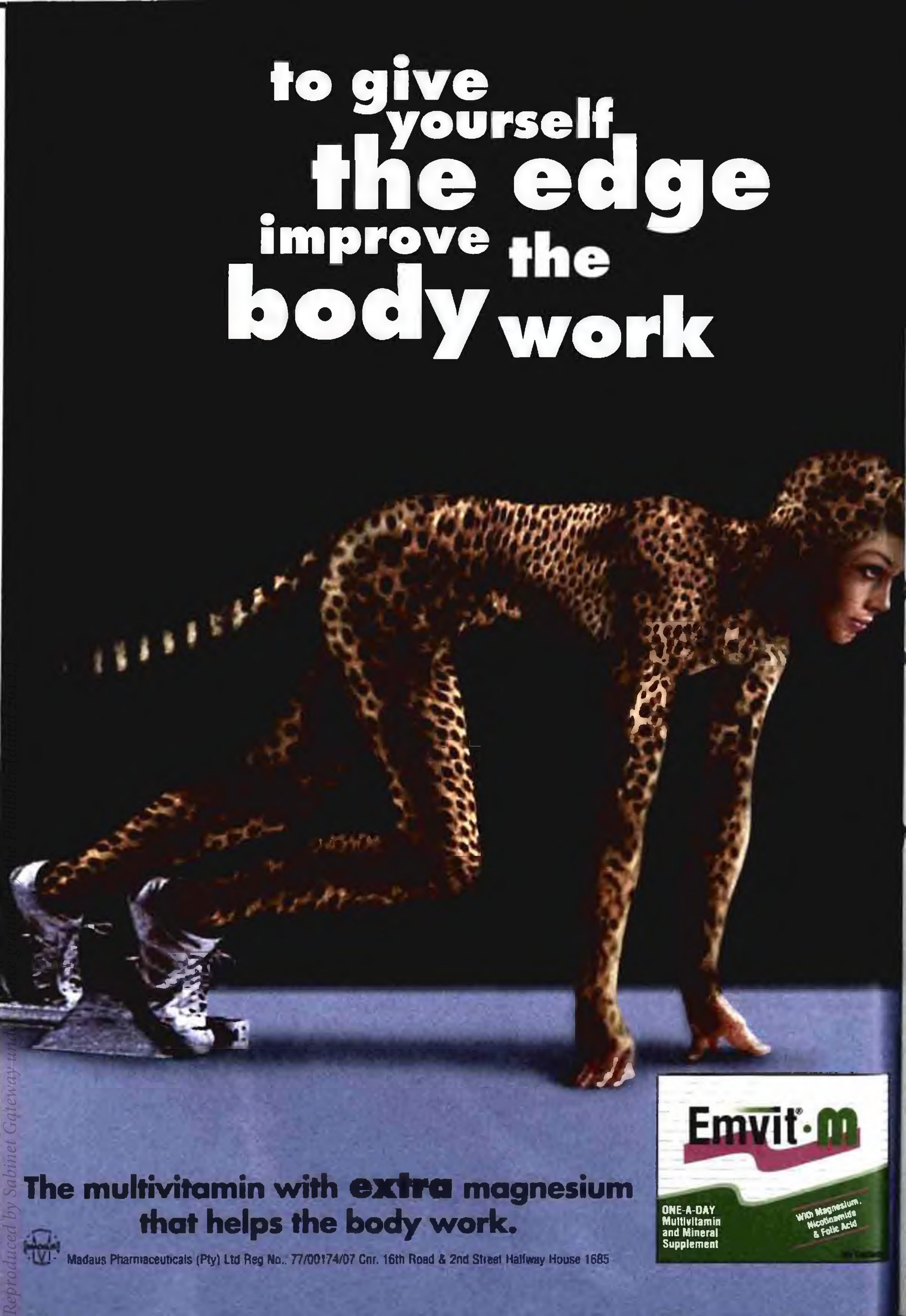
SOUTH AFRICAN JOURNAL OF

SPORTS MEDICINE

Vol 4 No 4 November 1997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EDITORIAL

Sport Psychology - Special Edition

It is an exciting propsect that this edition of SAJSM is entirely devoted to sports psychology. It marks another milestone in sport psychology's development in our country.

Since South Africa's re-entry to international sport, there has been growing interest in the discipline by athletes, coaches, sports administrators and the media alike. Judging by the enthusiasm shown by students, there is a similar keenness to meet the consequent demands. While this bodes well for the future of South African sport psychology, there are many organisational issues within the discipline which still need to be addressed.

One thing is clear however: Amidst all the academic and professional debates there is no doubt that the burgeoning interest has developed in response to a need - the need to understand and control the diverse influences which psychological factors have on sports performance and the general well-being of athletes. The varied nature of this need is reflected in the diverse topics and styles evident in this edition.

Pat Scott provides a theoretical overview of how physiological and psychological factors interact to make pain a complex and often misunderstood phenomenon. Anderson, Bassson, Geils and Farman's article on personality style, mood states and negative addiction, is representative of a body of research which has been included under both sport and health psychology. It focuses on the well-being of the general population rather than simply the performance of elite athletes.

In contrast to the theoretical and empirical based emphasis of the previous articles, Clive Basson's case-study provides readers with an insight into applied sport psychology. It is a source of practical ideas for the practitioner and athlete.

Finally, Olivier looks at physiological, kinematic and psychological differences between overground and treadmill running. While psychology is not the main emphasis, the paper clearly demonstrates the relevance of sport psychology to the other sports sciences - viz. adding a new dimension (in this case the influence of cognitive appraisal) to our undertsanding of concepts, lessens the variance which is unaccounted for in scientific research.

In light of the above, sport psychology expands sports science's knowledge of, and ability to contribute towards the well-being and performance of athletes. Should the traditional term "shrink" then not rather be replaced with "expander" ... ?!

Clinton Gahwiler
Guest Editor

THE SOUTH AFRICAN JOURNAL OF
SPORTS MEDICINE

VOLUME 4 NUMBER 4 NOVEMBER 1997

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The Editor
The South African Journal of Sports Medicine
PO Box 115, Newlands 7725

PRODUCTION
Andrew Thomas

PUBLISHING
Glenbarr Publishers cc
Private Bag X14
Parklands 2196
Tel: (011) 442-9759
Fax: (011) 880-7898

ADVERTISING
Marika de Waal/Andrew Thomas

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Concepts in Pain Mechanisms and Management

PA Scott Department of Human Movement Studies, Rhodes University

ABSTRACT
The challenge to understand the somewhat nebulous concept of pain has been around since Aristotle classified it as the "passion of the soul", and most athletes will have experienced pain to a lesser or greater degree at sometime in their career.

Although there is a clear physiological component as the body responds to some noxious stimuli, as soon as the pain sensation is 'felt' it becomes a personalised experience affected by a multitude of psychosocial factors. The interaction between physiological and psychological factors results in pain being a complex multi dimensional phenomenon which is not easily understood.

INTRODUCTION

Most people will experience pain at some stage in their lives, but no specific group is more likely to experience pain than athletes. Cliches like "No pain, no gain" and "pain is temporary, pride is forever" are part of a drive to push to, and beyond, athletes' physical limits. Pain has been identified as an integral part of the athletic experience and the phenomenon of pain is therefore of great relevance to all involved in sporting activities. John Heil of the United States, probably one of the most prolific writers on the psychological aspects of sport injuries, has identified pain as a "complex multidimensional phenomenon" which constitutes an everpresent challenge to the athlete[4]. The experience of pain associated with physical performance falls into three broad categories: Pain as a result of traumatic injury; Pain as the result of excessive physical demands; Pain suffered during the rehabilitative period as the result of one of the above.

As athletes are pushed to their physical limits their bodies are under continual stress, the result being that fatigue, discomfort and 'real pain' are common experiences. Thus an understanding of the concept of pain and its possible effects on performance warrants systematic investigation. Insight into the theoretical background of the complexity of the phenomenon of pain should help in understanding why athletes respond so differently to painful experiences.

Concept of Pain

It is interesting to note that Aristotle is reported to have classified pain as the "passion of the soul"; some defined pain as an unpleasant subjective experience familiar to everyone, while Heil[3] identifies pain as "... a complex biopsychological phenomenon". The vast array of definitions of pain, together with varying experiences of pain, give rise to the question as to whether pain is a physiological or psychological phenomenon.

Address for corespondence
Department of Human Movement Studies
Rhodes University
GRAHAMSTOWN

The identification of 'pain nerves' in the 19th century led to the classification of pain as a sensation and a recognition of pain as a complex percept; a combination of sensation, and affect, not just a simple sensory experience mediated through peripheral pathways alone: Mersky[6] wrote that, "Pain is a mixture of sensation and emotion". In other words pain is neither a purely physiological nor purely psychological phenomenon, but rather a complex interaction of both dimensions.

However, to gain a full understanding of this challenging concept it is necessary to first discuss the physiological components in isolation before addressing the psychological factors to be considered, and finally take an overview of the interaction of the two.

Physiological Factors or the Nociceptive System

Heil[3] describes the nociceptive system as a sub-division of the central nervous system which together with chemical mediators is responsible for the sensation and transmission of pain.

Pain is triggered by the activation of two identifiable types of receptors, viz the mechanoreceptors and the polymodal nociceptors. The mechanoreceptors respond to mechanical stimuli (ie external physical pressure) while the polymodal receptors respond to thermal and chemical stimuli and generally have a slower and longer lasting transmission, in which the receptors continue to fire for a time after the cessation of the pain - provoking stimulus. Having been transduced to neural energy,these impulses then travel along the afferent pathways of the peripheral nerves to the dorsal horn of the spinal cord which, according to Heil[3], functions as a sensory nerve "switching station". Here pain, together with other sensory stimuli from the periphery, converge upon common sensory neural pathways ascending to the brain. This is a very similar concept to the "Gate control" theory where Melzack and Wall[5], proposed that processing centres within the spinal cord may either decrease or increase the intensity of pain as a neuro-electrical phenomenon which results in the perception of relatively lesser or greater pain than that initially induced. In other words the pain stimuli are somehow modulated en route to higher cortical centres. The final perception of pain is based upon the summation of inputs from several areas of the brain including those responsible for memory and emotion. Heil[3] goes on to report that as a consequence of this input from various areas of pain, even at the stage of initial awareness, the perception of pain gains some of its meaning from prior experience together with the present state of mind of the athlete.

Once the experience of pain has registered, the brain sets off a cascade of electrochemical events within the nociceptive system, and this heightened activity within the neurochemical systems of the body will have a direct influence on the subsequent response to any pain-inducing stimuli.

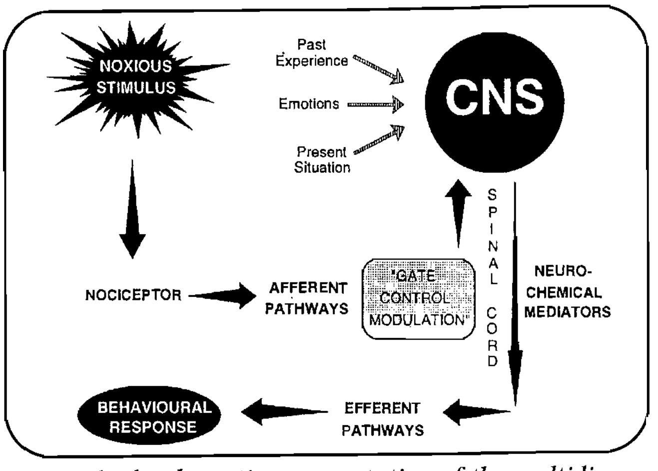

Figure 1: *A schematic representation of the multidimensional factors which contribute to the personalised experience of pain. (Adapted from Scott and Munton, 1995).*

However, although pain is recognised as being a physiological response, the intensity of that response is a phenomenological experience in that it is very specific to the individual and is greatly influenced by psychological factors. Skulety[13] pointed out that while numerous physiological factors give rise to the sensory phenomenon of pain, psychological components influence the individual's reaction to the pain. Norris[9] supports this argument by stating that the actual 'feeling' or being aware of pain stimuli is about the same for everyone, but acknowledges that the overall pain experience varies greatly from individual to individual.

Psychological Factors

Heil[3] reports that the instant the individual perceives the pain it becomes predominantly a psychological phenomenon; stating that perception sets off a psychologically driven chain of reactive events, all of which result in a personalised response to the pain. Fine [1] writes of pain being a 'private' experience and it is a well known fact that people respond very idiosyncratically in painful situations. The most basic reasoning behind this is human variability not only in the innate physical and mental make-up of individuals, but also their past experience, the present situation in which the pain is experienced, and finally a cognitive and affective analysis of how the pain situation could affect future performances.

Acknowledging the uniqueness of individuals, many researches have focused specifically on the personality of individuals and their response to pain. Petrie[10] identified different 'types' of people and their response to the experience of pain. There are the "augmentors" who appear to exacerbate the intensity of pain while "reducers" are those who do not appear to "feel" pain as much as others. Others have emphasised the cultural influences and argue that the importance of the social component in the response to pain has led to the characterisation of pain as a biopsychosocial phenomenon.

The main point here is the importance to recognise the network causality: - an athlete's response to pain will in all probability not depend on any one particular facet, but rather on the interaction of several personal (both physical and emotional) and social factors. The resulting individual perception of the pain will clearly affect one's personal response to the situation.

Melzack and Wall[5] in their classic paper on the subject, talk of pain as being biologically based with psychological dimensions. Clearly the primary factor must be physiological in that the noxious stimuli are detected by the sensory pain receptors. However, the affective component is the basis of the emotional response of the individual, and finally there is the cognitive component which will draw on personal appraisal of the entire ambience at the time of the injury.

Pain Threshold and Pain Tolerance

The actual experience of pain can be expressed in two distinct forms, viz the threshold of pain and pain tolerance.

The threshold of pain is the level of stimulus above which pain will be experienced[11] and is an unlearnt, innate physiological response; ie it involves the stimulation of the specialised pain receptors and many are now of the opinion that this pain threshold is very similar for everyone. On the other hand pain tolerance is the individual's endurance of the pain and is very much more a learnt response affected by various psychological factors, specifically the present situation: therefore the tolerance of pain varies greatly between people. Clearly a person's ability to tolerate pain is extremely important in most sporting environments, particularly in endurance type activities. Morgan[8] reported that the ability to perform successfully in a marathon is governed by the individual's physiological capacity together with a willingness and capability to endure extreme discomfort and pain. Whitmarsh and Alderman[15] propose that athletes with higher pain tolerance are likely to perform better than those with low pain tolerance; and Heil[4] proposes that many of the greatest sports victories are played out in a field of pain and injury.

Another useful conceptual dichotomy in the phenomenon of pain is that of acute and chronic pain. Simply put the former is short term or immediate pain, and the latter is long lasting pain. But is the temporal factor the only difference?

Acute pain is generally experienced at the time of the onset of trauma. Frymoyer and Waddell[2] state that acute pain usually bears a relatively straight forward relationship to the external cause, the intensity of the stimulus and tissue damage. They report that acute pain is generally proportional to the physical finding and usually has a specific location and is easily identifiable. While the dominant component of acute pain is physical, it is generally accompanied by the affective state of anxiety as the athlete worries about the severity of the injury.

This is in contrast to chronic pain which appears to be more diffuse in nature and is far more complex. Chronic pain tends to cause continual debilitating discomfort and become increasingly disassociated from the physical problems; becoming more increasingly associated with emotional distress, depression and a failure to cope. As pain continues, the individual becomes preoccupied with the pain and interpersonal functioning is adversely affected. This is commonly manifested as anger, hostility and even withdrawal from social contacts. Frymoyer and Waddle[2] warn that chronic pain may become a progressively self-sustaining condition, eventually becoming more psychological than physical. This argument is supported by Heil[4], who points out that pain becomes chronic when complaints of pain become a way of expressing distress and when inconsistencies in painful behaviour are noted.

Assessment of Pain

Due to the complex and highly subjective nature of pain it is difficult to gain a tangible, objective assessment of the amount of pain being experienced by the individual. The simple self-report scale of "0 to 10" (see Figure 2) is versatile and allows pain to be assessed across a variety of situations, and is accepted as a valid indicator of pain intensity. With regular use of the scale one can gain measures of 'average training pain' and 'worst injury pain', and so identify specific factors or situations that lead to an increase or decrease in pain. According to Heil[3] this line of enquiry and attempt to quantify the level of pain will in time provide insight into the physical challenges the athlete faces in training, competing and rehabilitation; the training and rehabilitating are of particular importance as they give one a perspective of the athlete's coping mechanisms and how effectively these are working.

PAIN PERCEPTION

0. **NORMAL**
1.
2. **UNCOMFORTABLE**
3.
4. **VERY UNCOMFORTABLE**
5.
6. **PAINFUL**
7.
8. **VERY PAINFUL**
9.
10. **EXTREMELY PAINFUL**

Figure 2: *The Pain Scale.*

Pain Management

It is not the focus of this paper to discuss the surgical or pharmacological measures which may be necessary to repair damaged tissue, but rather the focus is on the personal management of pain; in other words the psychological coping strategies.

Weinstein[14] wrote of pain as having a unique unpleasant affective quality, and in order to cope with this experience an athlete has to mobilise special resources. It should be noted that the experience of pain is a warning signal and it is important to realise that 'pain' is real to the sufferer; no matter how minor the injury appears to be, if an athlete complains about pain it is indicative that something is wrong. Millar[7] argues that all pain is felt in the mind - even the pain of a sprained ankle. Psychological problems associated with the experiences of pain will hinder athletic performance and should not be taken lightly. Athletes complaining of pain must be listened to and appropriate steps must be taken. There is a need to assess both the physical area as will as possible underlying factors. Heil[3] proposed a "pain-report attentional matrix" wherein cognisance must be taken of the sporting activity, the cause of the pain, plus the individual. In his conceptual scheme he identifies four broad classes of pain coping methods. These are defined by whether the athlete "focuses on" or "focuses away" from the pain and the activity simultaneously, or, whether there is a separation of attention between the activity and the pain. The coping strategy selected will depend on the individual, the situation, the activity and the interaction of these components.

At the time of the occurrence of an injury the athlete experiences pain, fear and anxiety. An injured athlete is likely to become lost in emotional and irrational thinking. It is therefore essential to create a sense of calmness and security by firstly identifying the site, cause and extent of injury; then shifting focus from the pain to thoughts of injury management, rehabilitation and positive outcome. Explain the mechanisms of injury and the treatment thereof, establish a rehabilitation programme, identifying pain as a routine aspect of rehabilitation. In other words acknowledge the problem and direct attention to the solution, keeping the athlete realistically aware of the situation and involved in the rehabilitative routine. The emphasis should be on a safe and speedy return to action.

It is also important to help the athlete differentiate between "acceptable or routine pain" and "dangerous pain". The former must be seen and accepted as 'normal' in the training, competing or rehabilitation programme and something which can and must be tolerated to a certain degree, while "dangerous pain" must be recognised as such and appropriate steps taken to eliminate the cause.

Conclusion

Pain is clearly a complex multi-dimensional phenomenon incorporating sensory, affective and cognitive components and it is only with a greater understanding of the general concept plus the individuality of response to pain that one will be better able to assist athletes to cope with PAIN.

References

1. *Fine PG (1993). The biology of pain. In J Heil: Psychology of sport injury. Champaign. Human Kinetics Publishers, pp 269-280.*
2. *Frymoyer JW and Waddle G (1991). Acute and chronic pain in MH Pope, GBJ Andersson, JW Frymoyer and DB Chaffin (eds). Occupational low back pain assessment, treatment and prevention. St.Louis: Moskey Year Book, pp 71-94.*
3. *Heil J (1993). Psychology of Sport Injury. Champaign, IL. Human Kinetics Publication.*
4. *Heil J (1995). Sports Medicine Injury Checklist. Sports Medicine Update, 10(3):16-19.*
5. *Melzack R and Wall PD (1965). Pain mechanisms: a new theory. Science, 150:971-979.*
6. *Mersky H (1973). The perception and measurement of pain. Journal of Psychosomatic Research, 17:251-255.*
7. *Millar AP (1995). The psychology of sport. Sports Medicine update, 10(3):13-15.*
8. *Morgan WP (1981). Psycho-physiology of self awareness during vigorous physical activity. Research Quarterly for Exercise and Sport, 52(3):385-427.*
9. *Norris CM (1993). Sports injuries: diagnosis and management for physiotherapists. London. Butterworth-Heinemann.*
10. *Petrie A (1967). Individuality in pain and suffering. Chicago: The University of Chicago Press.*
11. *Scott PA and Mackenzie B (1992). Pain and how workers handle it. Safety Management, 1(3):14-16.*
12. *Scott PA and Munton L (1995). Athletes' perception of pain. Paper presented at 6th South African Sports Medicine Association Congress. Durban South Africa.*
13. *Skulety FM (1984). The management of the chronic pain patient: clinical considerations. Journal of Orthopaedic and Sports Physical Therapy, 5(6):305-307.*
14. *Weinstein J (1991). Neurophysiology of pain. In TG Mayer, V Mooney and RJ Gatchel (eds): Contemporary conservative care for painful spinal disorders. Philadelphia: Lea and Febiger, pp 67-73.*
15. *Whitmarsh BG and Alderman RB (1993). The role of psychological skills training in increasing athletic pain tolerance. The Sport Psychologist, 7:388-399.* □

Personality Style and Mood States Associated with a Negative Addiction to Running

SJ Anderson MSc (Clin Psych) (Natal)
CJ Basson BEd. (UNISA), UED (Natal), MA (Psych) (Natal).
C Geils BA (Hons), and R Farman BPhil MEd (Birmingham)

ABSTRACT

Personality subtypes and mood states were investigated in addicted and non-addicted runners (n = 49), and contrasted with a control group of non-exercisers (n = 34). Runners were assigned to a non-addicted and addicted group on the basis of Hailey and Bailey's Negative Addiction Scale, and all study participants were then asked to complete a biographical questionnaire, the Profile of Mood States (POMS) and Millon Clinical Multiaxial Inventory (MCMI). Results revealed a group difference on the Vigor subscale of the POMS, while the Total Mood Disturbance score discriminated the non-addicted runners and the non-exercisers. Although a trend towards disturbed mood was evident for the addicted runners, this failed to reach statistical significance. The MCMI revealed a number of group differences in personality subtypes (Avoidant, Dependent, and Schizotypal), as well as for more transient clinical symptomatology (Anxiety and Dysthymia). Taken together, the results suggest that high addiction to running is associated with discrete personality and mood profiles that may contribute to diminished health benefits of running and exercise. The study findings are discussed with reference to personality theory, and implications for further research in this area.

INTRODUCTION

It is well known that some athletes engage in intermittent and moderate running, whereas others run with persistent and stubborn regularity. For the latter, running becomes an activity of central importance in their lives to the exclusion of all other recreational activity, suggestive of the properties of addiction. Sachs and Pargman,[4] define exercise addiction as:

> Psychological and/or physiological dependence upon a regular regimen of physical activity. Additionally, exercise addiction is characterized by recognizable withdrawal symptoms when the need to exercise remains unfulfilled after 24 - 36 hours. These withdrawal symptoms may encompass both psychological and physiological factors, including feelings of irritability, tension, guilt, uneasiness, bloatedness, muscle twitching and discomfort (p. 143).

Various terms are used in the literature to describe this phenomenon, including running addiction, obligatory running, running dependence, and compulsive running. The origins of the term running/exercise addiction date back to the late 1960s,[2] and have resulted in a distinction being made between positive and negative addiction. This development resulted from a need to emphasise the detrimental physical and psychological effects resulting from a dependence on running. The transition from positive to negative addiction has been linked to a time dimension,[9,19] and is described by Sachs[2] as resulting from running shifting from being an important but well considered aspect of the runner's existence, to one that controls the runner's life. The major result is that choices in other important areas of the individual's life are eliminated and /or reduced.[2] Such runners were found to adhere to a regular pattern of running behaviour and maintain it despite debilitating pain, injuries and medical advice, and in preference to social, familial or professional responsibilities.[2] Noakes and colleagues, and de Coverley Veale cite cases of runners with diagnosed myocardial infarction, who ignored severe symptoms while running, and as a result died from myocardial infarcts during marathon events.[5,6] A further refinement following on the observed relationship between exercise addiction and anorexia nervosa, has been introduced by Veale[3] who distinguishes between primary and secondary exercise addiction. The latter he sees as suggestive of the presence of an eating disorder, whereas the former he suggests not being related to any discrete mental disorder.

Etiological explanations have included both physiological and psychological perspectives. The former proposes that increases in levels of plasma B-endorphin released into the central nervous system in response to the stress of exercise, with subsequent mood enhancing and analgesic effects, are responsible for the development of addiction;[9,16] however, the findings are equivocal.[6] What has not been established, is why only some individuals become addicted to running. Psychological investigations into the personality characteristics associated with running and running addiction in general have been conducted.[2,22,25,26] Recent overviews of the relationship between sport and personality have sketched the long history of dispositional approaches to the study of this relationship.[30,31,32] This trend has been questioned and the use of more interactional paradigms has been strongly advocated.[30,31] Cox is more optimistic especially if use is made of relevant theory as well as multivariate statistical methodology such as regression analyses.[16] Most studies have made use of inventories such as the 16PF, the Minnesota Multiphasic Personality Inventory (MMPI), the Eysenck Personality Questionnaire (EPI) and the Profile of Mood States (POMS) to measure personality dimensions, but few have used the theoretical underpinnings of the questionnaire to inform their research questions.[30,31,32] Vealey, in her review, concludes that regardless of the fact that there is evidence to suggest that runners' personalities are characterised by introversion, stability, low anxiety, self-sufficiency, high self-esteem and imaginativeness, no prototypical athletic personality type has yet been defined.[31]

Address for Correspondence:
SJ Anderson,
Department of Psychology, University of Natal (PMB),
P. Bag X01, Scottsville, 3209.
Tel: (0331) 260-5372
email: andersons@psy.unp.ac.za

With regard to personality and addiction, Steinberg and Sykes[11] cite Pargman and Baker's review of the literature, suggesting that there may be underlying similarities in the psychological profile of addicts generally. The idea of an addictive personality type has, however, not received much support from current research. Nonetheless, researchers continue to investigate the personality profile of the addicted exerciser, and more particularly the runner.[2,11,22,27,28]

A specific personality attribute associated with addiction, and suggested to be common to addicted exercisers and anorexics, is the obsessive-compulsive and anxious constellation.[1,2,3] Compulsive individuals may be attracted to running as a coping strategy for stress because of the repetitive routinized nature of the activity and its capacity to facilitate control over mood states as well as physical appearance and functioning.[7] Although some research supports a higher incidence of obsessive-compulsive features and anxiety in addicted runners, other evidence suggests that runners present with diverse personality traits without significant pathology.[3,6,13,31] Blumenthal, O'Toole and Chang found that addicted runners scored within the normal range on the MMPI, and in addition found that even the most severely addicted runners did not exhibit significant psychopathology as measured by the MMPI.[13] They argued that a disease model of the addicted runner was misleading and unnecessarily pejorative. Yates, Shisslak, Allander and Crago found the obligatory and non-obligatory runners in their study to have more similarities than differences, although obligatory runners tended to prefer social isolation.[29] Others have found male obligatory runners to be more motivated by achievement and a need for recognition.[28] Thus some trends have emerged in recent research although no theoretical conceptualisation of personality or running addiction has informed these studies.

A further area of interest to the present study is the relatively well established finding that exercise results in an increase in positive mood states and a decrease in negative mood states (e.g. anxiety and depression), and that physical exercise is associated with positive mood.[14,15,16,31] Chan and Grossman[17] cite Morgan and Pollock as noting that, compared to non-exercisers, runners were found to be lower in depression, fatigue, confusion, and tension as measured by the POMS, and hypothesized that these mood differences were a positive consequence of running. Millon[25] cites Morgan as finding similar evidence, and naming this constellation of scores the 'Iceberg profile' by virtue of it's visual graphic configuration. This finding may also indicate that individuals with more positive mood characteristics choose to exercise, and that addicted runners do not derive the positive mood benefits from running.

Purpose of the study

In view of the uncertain findings in the literature on the relationship between personality and mood states and running addiction, this study aimed to examine whether negatively addicted runners are characterized by a compulsive personality style (as measured on the Compulsive scale of the MCMI). Furthermore it was proposed to examine whether there are any other personality differences that distinguish negatively addicted runners from non-addicted runners, and whether addicted runners tended to demonstrate greater mood disturbance on the POMS. Further investigation into these variables could shed light on management and intervention programmes for use by clinicians, coaches, and athletes.

Theodore Millon's Biosocial Learning Theory of personality was used to conceptualise personality functioning.[24,26] Personality is defined by Millon as:

> A distinctive configuration of interlocking perceptions, feelings, thoughts and behaviors that provide a template and disposition for maintaining psychic viability and stability (p. 643).[26]

Pathology is viewed as occupying the extreme end of a continuum of normal behaviour, and differentiated by the following three features: functional inflexibility and rigidity; a tendency to foster vicious or self defeating circles of behaviour; and tenuous structural stability under conditions of stress.[26] Each personality scale is thus constructed on the basis of a personality prototype rather than a syndrome or type against which individuals are compared for their closeness of fit.[27] Each prototype is made up of a "small and distinctive group of primary attributes that persist over time" (p. 673), that are utilised by the individual to ensure predictability, viability, and control in adaptive contexts. These prototypes have been operationalized in the Millon Clinical Multiaxial Inventory (MCMI) and its revisions (MCMI-II and MCMI-III).

METHODOLOGY

Subjects

An opportunity sample was secured from a list of members of a university athletics club and a list of those runners from the club who had completed the Comrades Marathon in that year. The remaining runners were drawn from two running clubs in KwaZulu-Natal on the basis of their commitment to a regular running programme. The final sample consisted of 49 runners (33 males and 16 females), ranging in age from 19 to 63 (= 25.84 years).

A comparison group of 34 non-exercisers (14 males and 20 females) was selected by opportunity sampling, from a university staff/student population. They ranged in age from 19 to 50 (= 23.2 years). They were selected on the basis that they did not participate in regular exercise (i.e. two or more times a week). Exercise was either sporadic and/or primarily of a low intensity, e.g. casual walking or yoga. $\bar{x}$

The runners were assigned to one of three groups on the basis of their scores on the Hailey and Bailey Negative Addiction Scale (see results section).[19]

$\bar{x}$

INSTRUMENTS

Information Questionnaire

This instrument included biographical information and questions relating to the different types of exercise the subjects typically engaged in, the intensity, frequency, duration of such exercise, and motives for exercising.

The Negative Addiction Scale

The Negative Addiction Scale (NAS) was designed by Hailey and Bailey[19] to objectively quantify the psychological aspects of Morgan's concept of 'negative addiction'. It is a 14-item questionnaire that yields a single addiction score ranging from 0 (low) to 14 (high). First and Germone[9] found that although the maximum score on this scale is 14, the most highly addicted runners in their study had a mean addiction score of 6.38. No research has been done to identify the point on this scale at which the onset of addiction to running occurs.[9] The psychometric properties of this scale (ie. validity and reliability) are not mentioned, but it was, however, the most available scale at the time of the research. Thornton and Scott[22] have subsequently used this scale with some success.

Profile of Mood States (POMS)
The POMS[23] was designed to measure transient and fluctuating mood states,[10] although it is regarded by some researchers,[31,32] as a dispositional measure rather than a state measure of personality. The scale is noted by Morris[32] as having been extensively used in at least 12 studies successfully distinguishing levels and types of athletic performance. It has 65 items that consist of adjectives describing various feelings and moods, each of which is rated on a 5-point intensity scale. The results yield six dimensions of mood: tension/anxiety; depression/dejection; anger/hostility; vigor/activity; fatigue/inertia; confusion/bewilderment. Vigor is subtracted from the total of the other five mood states to provide a Total Mood Disturbance score, with a high score indicating poor adjustment. This Total Mood Disturbance score is highly reliable because of the inter-correlations among the six primary POMS factors, and reliability of the scales ranges from 0.65 to 0.90.[23]

Millon Clinical Multiaxial Inventory (MCMI)
The MCMI[24] consists of 175 items, from which 20 scales are derived. Scales 1 - 8 reflect the persistent, ingrained, enduring and pervasive personality characteristics or 'personality style' of an individual. Scales S, C, and P reflect a greater level of pathology in the personality pattern, while scales A through PP are clinical syndrome dimensions that reflect current symptom states of a transient nature (i.e. symptoms that fluctuate over time in response to the impact of stressful situations). These latter symptoms typically exacerbate the basic personality style.

Test-retest reliability indicates that the overall stability of the MCMI scales is reasonable, with an average around 0.80 for both the personality patterns and the pathological personality scales.[24] Stability for the clinical syndromes, which are more transient and will inevitably fluctuate, is lower at 0.65.[24] Concurrent validity was supported by correlational data between the MCMI scales and three comparable diagnostic inventories, including the MMPI. Base rate scores provide uniform cutting lines: the BR75 cutting line is drawn to identify the presence of a trait or disorder. The BR85 cutting line represents the most prominent syndrome(s).

RESULTS

(a) Negative Addiction
Administration of the NAS to the runners revealed a wide spread of scores (range 1-13; = 3,82, SD = 2.45). Following the findings of Hailey and Bailey, the runners were assigned to one of three groups on the basis of their level of negative addiction on the NAS (see Table 1). The high addiction subgroup comprised 11 runners (6 male, 5 female) scoring 6 or more on the NAS (Hailey and Bailey note that the mean addiction score for the most highly addicted runners in their sample was 6.38; SD = 2.61). The low addiction subgroup consisted of a group of seven male and three female runners, with negative addiction scores of 4 and 5. The non-addicted subgroup (21 male, 6 female) were identified on the basis of their NAS scores between 1 and 3. A median split technique of the Negative Addiction Scale scores (median = 3) supported this grouping.

Table I.
Sub-Groupings of Runners on the Negative Addiction Scale (n = 49)

Subgroup	n	mean	SD	Range
High addiction	11	6.36	1.27	6-13
Low addiction	10	4.10	0.32	4-5
Non-addicted	28	2.21	0.75	1-3

A series of one-way ANOVA's failed to reveal any group differences between the high and moderate addicted runners on any of the variables, and so these two groups were collapsed into a single group (addicted runners; = 3.80; SD = 2.46) for the remainder of the statistical analysis.

(b) Mood States
The results for the three groups on the Profile of Mood States (POMS) are summarized in Table II (groups collapsed for sex) and Figure 1.

Table II.
POMS Raw Scores (and SDs) for the Addicted and Non-Addicted Runners, and the Non-Exercisers.

Scale	addicted runners	non-addicted runners	non-exercisers
Tension	9.90 (6.08)	7.78 (4.17)	10.12 (5.48)
Depression	8.90 (7.61)	5.15 (4.26)	10.57 (9.68)*
Anger	8.65 (7.47)	5.07 (3.80)	10.57 (9.68)*
Vigor	21.00 (4.88)	20.96 (3.03)	14.24 (5.90)**
Fatigue	7.20 (5.84)	4.81 (4.10)	8.91 (5.43)*
Confusion	7.80 (6.01)	6.07 (3.35)	8.36 (5.17)
TMD	21.15 (25.01)	7.93 (14.56)	33.59 (28.36)**

*significant group difference *p <.05; **p <.001*
TMD = Total Mood Disturbance

A significant difference between the non-exercisers and non-addicted runners, emerged on the Anger ($F = 3.53$, $p < 0.05$), Depression ($F = 3.76$, $p < 0.05$), Fatigue ($F = 4.73$, $p < 0.05$) and Total Mood Disturbance ($F = 8.8\ 1$, $p < .00\ 1$) scores of the POMS (Scheffe' post-hoc, $p < .05$). The Vigor subscale also revealed a significant difference ($F = 18.76$, $p < 0.001$), between the runners as a whole, and the non-exercisers (Scheffe post-hoc). In order to assess the clinical significance of the POMS scores, the groups were compared for the presence of scores (excluding Vigor), above the clinical cut-off point of $T \geq 60$. Results revealed a significant group differences using Chi-squared ($F = 9.16$, $p < 0.02$), with the non-addicted runners showing less overall emotional disturbance than the non-exercisers. The POMS Vigor scale was examined separately (it is the only positive mood state), and showed that the non-exercisers reported less vigour than the addicted and non-addicted runners ($F = 13{:}21$, $p < 0.001$). Since the scoring of the POMS is not adjusted for sex, investigation of potential gender differences was made using a two-way ANOVA (group by sex); however, this failed to reveal any profile differences between males and females.

(c) Personality and psychopathology

Group data for the MCMI basic personality profiles and clinical symptom scales are shown in Table III and Figure 2. A series of one-way ANOVA's revealed significant group differences for two of the personality scales (Avoidant, Dependent, and Schizotypal), as well as for two of the clinical syndrome scales (Anxiety and Dysthymia).

Post-hoc group comparisons (Scheffe, $p < .05$) showed that the addicted runners differed significantly from the non-addicted runners on the Avoidant ($F = 4.29$, $p < .05$), Schizotypal ($F = 5.56$, $p < 0.05$), and Anxiety ($F = 3.27$, $p < 0.05$) scales, whereas the scores of the Dysthymic scale showed that the non-addicted runners were less depressed than both the addicted runners and non-exercisers ($F = 4.92$, $p < 0.01$). In order to check for the presence of clinical pathology on the MCMI, subject profiles

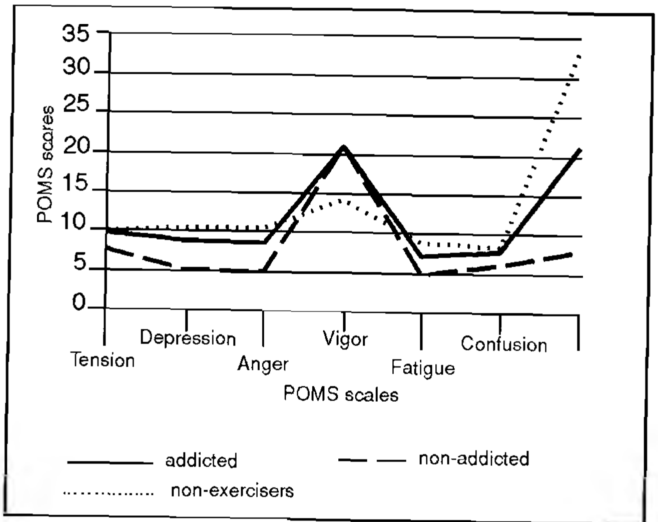

Figure 1. *POMS scores for addicted and non-addicted runners, and non-exercisers.*

were examined for the presence of personality and symptom dimension scores at or above the clinical cut-off base rate of BR75. Although there were a number of individual cases in which the cut-offs were exceeded, there were no overall group differences suggestive of pathology for the clinical syndromes ($F = 3.75$, $p < 0.20$); pathological personality scales of Schizotypal, Borderline and Paranoid ($F = 1.09$, $p < 0.20$); or the basic personality scales ($F = 3.86$, $p < 0.10$) using Chi-squared.

To further investigate personality differences between groups, one-way (group) and two-way (group by sex) ANOVA's were run using the MCMI scales that were suggested in a four fold factor matrix by Millon.[24] Significant group ($F = 4.12$, $p < 0.05$) differences emerged for Factor 1 with a post hoc Scheffe ($p < 0.05$) analysis indicating that the addicted runners were more emotionally labile and depressed than the non-addicted runners. Factor 1 is described by Millon[24] as "depressed and labile emotionality expressed in affective moodiness and neurotic complaints" (p. 49). The scales with maximal positive loadings (> 0.80), on this factor were Borderline, Dysthymia, Anxiety, Psychotic Depression, Passive Aggressive and Histrionic. The Avoidant, Schizotypal, Hypomanic and Psychotic Thinking scales loaded between 0.40 and 0.80. The Compulsive scale loaded significantly negatively on Factor 1 (-0.747). Group by sex ($F = 2.644$, $p = 0.077$), and group ($F = 2.963$, $p = 0.057$), differences approached significance on Factor 3. The addicted male runners tended to be more asocial and avoidant, and low on sociability and self confidence. Factor 3 is described by Millon[25] as a "core pattern of schizoid behavioural detachment and thought

Table III.
MCMI Base Rate (BR) Means and SDs for the Addicted and Non-Addicted Runners, and the Non-Exercisers.

Scale	Personality patterns addicted runners	non-addicted runners	non-exercisers
Schizoid (1)	39.29 (25.53)	26.25 (17.05)	33.85 (23.28)
Avoidant (2)	40.80 (21.31)	23.54 (19.12)	28.71 (21.60)*
Dependent (3)	68.52 (23.41)	50.14 (28.24)	48.97 (26.56)*
Histrionic (4)	66.71 (20.46)	73.04 (15.69)	74.26 (24.86)
Narcissistic (5)	63.52 (13.71)	70.79 (15.37)	69.56 (20.83)
Antisocial (6)	56.76 (20.67)	62.00 (20.66)	58.24 (20.01)
Compulsive (7)	65.71 (17.34)	64.50 (9.30)	64.06 (11.38)
Passive-aggressive (8)	36.42 (24:42)	30.75 (14.20)	39.53 (21.21)
Schizotypal (S)	56.48 (10.03)	40.39 (20.30)	44.71 (17.56)**
Borderline (C)	57.52 (16.17)	46.75 (18.54)	54.91 (19.22)
Paranoid (P)	60.38 (17.85)	63.43 (13.15)	56.85 (19.46)
Clinical syndromes			
Anxiety (A)	74,67 (15.28)	59.93 (21.67)	68.44 (21.82)*
Somatoform (H)	73.33 (14.94)	65.32 (17.57)	68.12 (14.62)
Hypomanic (N)	47.95 (30.60)	50.79 (21.38)	46.85 (28.50)
Dysthymic (D)	64.52 (15:33)	49.39 (18.72)	62.15 (21.02)**
Alcohol Abuse (B)	46.57 (19.64)	47.29 (13.03)	47.03 (21.07)
Drug Abuse (T)	56.00 (18.69)	61.79 (14.31)	56.06 (24.31)
Psychotic Thinking (SS)	51.38 (9.98)	41.46 (21.73)	44.24 (17.86)
Psychotic Depression (CC)	41.33 (17.27)	34.82 (15.89)	40.47 (18.85)
Psychotic Delusions (PP)	52.76 (18.48)	49.89 (20.21)	47.29 (22.24)

*significant group difference *(p <.05) **(p <.01)*

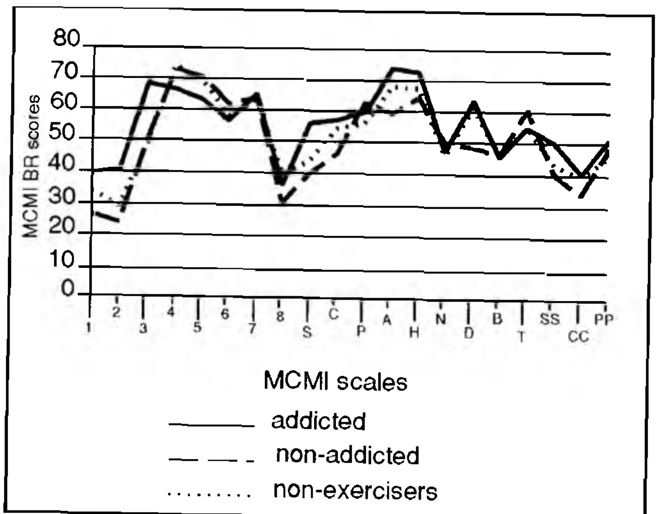

Figure 2. *MCMI Scores for the Addicted and Non-Addicted runners, and Non-Exercisers.a*

with positive loadings on schizoid, avoidant and psychotic thinking" (p. 50). Sex differences approached significance ($F = 3.681$, $p = 0.059$) on Factor 4, with females showing a trend of greater social restraint than the male runners. There were no significant group or group by sex differences on Factor 2, (this factor is related to paranoid thinking and behaviour with associated grandiosity and suspiciousness). The addicted runners thus tend to be emotionally labile, and this is associated, particularly in the male runners, with low sociability and low self confidence.

In order to identify which MCMI personality scales best predicted group membership for addicted and non-addicted runners, a Discriminant Function Analysis (DFA) was performed. This was preceded by a factor analysis (n = 49) in which four factors were extracted (varimax rotation); these were: Factor 1 - Somatization (0.92), Dependent (0.84), Borderline (0.76), Anxiety (0.75), and Antisocial (-0.79); Factor 2 - Drug Abuse (0.87), Alcohol Abuse (0.82), Hypomania (0.73), Passive-Aggressive (0.70), Histrionic, and Compulsive (-0.71); Factor 3 - Schizoid (0.88), Avoidant (0.79), Schizotypal (0.72), Psychotic Thinking (0.66), and Histrionic (-0.62); while Factor 4 was comprised of Psychotic Delusions (0.97) and Paranoid (0.68). An insufficient number of variables left in the correlation matrix excluded the identification of any further factors.

Three of these factors (namely Factors 1, 3 and 4), successfully discriminated the addicted and non-addicted runners (respective Wilks' lambda were: .84 for Factor 3 ($p < 0.005$); 0.80 for Factor 1 ($p < 0.006$); and 0.78 for Factor 4 ($p < 0.009$). Canonical discriminant function coefficients were 0.417, 0.901 and -0.44 for the respective factors F 1, F3 and F4. The results of the DFA found that these factors were successful in classifying 76.2% of the addicted runners and 71.4% of the non-addicted runners. The overall correct classification was 73.47%.

A stepwise multiple regression analysis was also performed with scores from the NAS as the dependent variable. The first predicted variable was duration of exercise, which accounted for 21% of the NAS variance ($F = 11.4$, $p < 0.01$). With the addition of the Schizotypal Personality subscale from the MCMI, this percentage increased to 31% ($F = 9.3$, $p < 0.001$). Finally, the addition of a third predictor, namely sex, accounted for 40% of the overall variance of the NAS scores ($F = 8.8$, $p < 0.001$).

Finally, in order to identify which variables best predicted Schizotypal Personality, an additional stepwise multiple regression analysis was performed on the data. On the first step, the Total Mood Disturbance score (POMS) emerged as the significant variable, accounting for 16% of the variance ($F = 7.9$, $p < 0.01$). The second variable (duration of exercise) accounted for a further 9% (total variance 24%; $F = 6.5$, $p < 0.0 1$). Finally, intensity of exercise (questionairre data) contributed a further 11 % (total 3 5%; $F = 7.2$, $p < 0.00 1$). The 0.05 limits were reached following this last extracted variable.

DISCUSSION

The identification of addicted versus non-addicted runners using an arbitrarily-determined cutoff point on the NAS was the source of some concern to the researchers. However, a median split of 3 in the current study suggested that the cut-off point used by Hailey and Bailey[19] was compatible with our own findings, and represents a useful clinical guideline. We would support a view that further psychometric research is desirable to fully explore the validity of NAS cut-off points.

The most prominent feature of the POMS was the 'iceberg profile' that distinguished the two running groups (high and low addiction) from the non-exercisers (see Fig. 1). This finding is consistent with previous research that has found that exercising individuals are characterised by higher levels of energy (Vigor) and lower levels of emotionality than non-exercisers.[18,23] The other POMS findings (i.e. Total Mood Disturbance score, Anger, and Fatigue) also appear to suggest that running is associated with emotional well-being; however, analysis of non-significant trends in the data suggest that this benefit is maximal for the non-addicted runners. It should be pointed out that considerable overlap exists in the Total Mood Disturbance scores for the addicted and non-addicted runners, as well as for the addicted runners and non-exercisers (see Table II).

The MCMI results lend themselves to useful clinical interpretation. While the results revealed few significant overall group differences, the finding that the addicted runners were significantly different from both the non-addicted runners and non-exercisers on the Dysthymic scale provides further support for the idea that non-addicted running either promotes positive mood states, or reduces depressed mood. In terms of personality profiles, our results suggest that running addiction is correlated with specific personality dispositions, in particular, the Schizotypal personality. This refers to a constellation of personality dispositions characterized primarily by social detachment, a preference for privacy and isolation, and the display of unobtrusive aloofness associated with a tendency towards behavioural eccentricities and low self esteem.

In addition, there was evidence of a weaker correlation between running addiction and Avoidant and Dependent personality patterns. The Avoidant pattern has similarities with the Schizotypal disposition in that it is also characterised by social detachment, but with greater emotional lability, tension, and anger. Of interest to the overall aim of this study was the finding that running addiction is not represented by a personality profile that features prominent compulsive dispositions. This dissociation between what on the surface might appear to be compulsive behaviour (i.e. running addiction), and compulsive personality traits, can be interpreted with reference to Millon's theory of personality as operationalized in the MCMI. To this extent, addicted running appears to be more closely associated with general, rigid, inflexible personality patterns of a schizotypal and avoidant nature, in which emotionality has higher prominence than the compulsive personality disposition which Millon describes as being characterised by restrained emotionality. The significant negative correlations (from -.17 to -.38), between the Compulsive sub-scale on the MCMI and all of the POMS subscales, supports this observation.

A further point worth noting concerns the largely negative correlations (from a non-significant -0.03 to a significant -0.27), between most of the MCMI clinical scales and the Vigor subscale of the POMS. This relationship confirms the common sense expectation that increased feelings of energy and well-being would be incompatible with psychological symptomatology in runners. This is particularly so in relation to the Dysthymia sub-scale, where the relationship is significantly negative ($r = -0.27$, $p < 0.01$). Other comparisons between the two clinical instruments used in this study are suggestive of an association between negative mood state (as measured by the POMS), and a tendency towards specific types of personality dispositions. For example, our results suggest negative correlations between the Total Mood Disturbance score and the Compulsive personality subtype (-0.31), and high positive correlations ($p < 0.001$) with Avoidant (0.41), Passive Aggressive (0.55), Schizotypal (0.34), and Borderline (0.49). Somewhat weaker correlations characterized the relationship between Total Mood Disturbance and Schizoid (0.28) and Narcissistic (-0.28) personality subtypes.

In relation to previous research documenting the relationship between running addiction and personality,[13,28,29] there is some concordance with the Yates et al. study that found obligatory runners to prefer social isolation.[29] However, Blumenthal et al. found no significant differences between addicted and non-addicted runners using the MMPI, and they caution against pathologizing running addiction.[13] The findings of the present study cannot be directly compared to the Blumenthal study as the theoretical underpinnings of the MMPI and the MCMI are somewhat different. The rational for the MCMI is a theory of personality, whereas the MMPI is based on a theory of psychopathology. Furthermore, Millon describes personality traits as dispositions, and views his sub-types as prototypes against which persons are compared for their closeness of fit; this has important implications for interpretation of findings such as ours.[26,27] Millon stresses that the personality dispositions of the person approximate the prototype to a greater or lesser degree, rather than being classified into discrete, pathological categories. To this extent, we would concur with Blumenthal and colleagues, that a rigid categorisation of athletes into personality and psychopathological subtypes is misleading and undeserving. Specifically, researchers need to contextualize their results and interpretations with reference to the theoretical underpinnings of the instruments used. Such an approach, would hopefully lead to increased understanding of the dynamic psychological processes underlying running addiction.

In terms of our suggestions for further research, the extent to which our findings are generalizable to other sports would be an important extension. Further studies on the utility and reliability of the NAS also seem warranted, given that parameters of running addiction (e.g. stage-like process) have not yet been sufficiently operationalised, despite pioneering attempts in this regard.[20,19,22] In view of the criticisms directed at personality trait research,[31,32,33] the use of more interactional and idiographic research designs, in an attempt to examine the relationship between personality and running more specifically, needs to be implemented. Furthermore multi-disciplinary and multivariate statistical procedures that include biophysical, psychological and sport skill variables,[34] may be useful in furthering the knowledge base in this important area of sport psychology.

References

1. Coen SP & Ogles BM (1993). *Psychological characteristics of the obligatory runner: A critical examination of the Anorexia Analogue Hypothesis. Journal of Sport and Exercise Psychology, 15,338-354.*
2. Sachs ML (1981). *Running Addiction. In M Sacks & M Sachs (Eds.), Psychology of Running. pp. 116-125. Champaign Ill: Human Kinetics.*
3. Veale D (1995). *Does primary exercise dependence really exist? In J Annett, B Cripps, and H Steinberg (Eds.), Exercise Addiction: Motivation for Participation in Sport and Exercise. London: BPS.*
4. Sachs ML & Pargman D (1979). *Running addiction: A depth interview examination. Journal of Sport Behaviour, 2, 143-155.*
5. Colt EWD, Dunner DL...Hall K & Fieve RR (1981). *In M Sacks & M Sachs (Eds.), Psychology of running. pp. 234-245 Champaign Ill: Human Kinetics.*
6. De Coverley Veale DMW (1987). *Exercise Dependence. British Journal of Addiction, 82, 735-740.*
7. Sacks MH (1981). *Running addiction. A clinical report. In M Sacks & M Sachs (Eds.), Psychology of Running pp. 127-129.Champaign Ill: Human Kinetics.*
8. Biddle SJH & Mutrie N. (1991). *Psychology of Physical Activity and Exercise. London: Springer-Verlag.*
9. Furst DM & Germone K (1993). *Negative addiction in male and female runners and exercisers. Perceptual and Motor Skills. 77, 192-194.*
10. Kremer JMD & Scully DM (1995). *Psychology in Sport. London: Taylor Francis.*
11. Steinberg H & Sykes EA (1985). *Introduction to symposium on endorphins and behavioural processes: Review of literature on endorphins and exercise. Pharmacology, Biochemistry and Behaviour, 3, 857-862.*
12. Sours JA (1981). *Running, anorexia nervosa and perfection. In M Sacks & M Sachs (Eds.), Psychology of running pp. 80-89. Champaign Ill: Human Kinetics.*
13. Blumenthal JA, O'Toole LC & Chang JL (1984). *Is running an analogue of anorexia nervosa? Journal of the American Medical Association, 252, pp 520-523.*
14. Marcus BH, Bock BC, Pinto BM & Clark MM. (1996). *Exercise initiation, adoption and maintenance. In JL van Raalte & BW Brewer (Eds). Exploring Sport and Exercise Psychology, Washington: APA. pp 133 -158.*
15. Sime W (1996). *Guidelines for the clinical applications of exercise therapy for mental health. In JL van Raalte & BW Brewer (Eds). Exploring Sport and Exercise Psychology. Washington: APA. pp 159-186.*
16. Cox R (1994). *Sport Psychology: Concepts and Applications. Maddison Brown & Benchmark.*
17. Chan CS & Grossman HY (1988). *Psychological effects of running loss on consistent runners. Perceptual and Motor Skills, 66, 875-883.*
18. Gondola JC & Tuckman BW (1982). *Psychological mood state in 'average' marathon runners. Perceptual and Motor Skills, 55, 1295-1300.*
19. Hailey BJ & Bailey LA (1982). *Negative addiction in runners: A quantitative approach. Journal of Sport Behaviour, 5, 150-154.*
20. Biddle SJH & Fox KR (1989). *Exercise and health psychology: Emerging relationships. British Journal of Medical Psychology, 62, 205-216.*
21. Rudy EB & Estok PJ (1990). *Running addiction and dyadic adjustment. Research in Nursing and Health. 13, 219-225.*
22. Thornton EW & Scott SE (1995). *Motivation in the committed runner: Correlations between self-report scales and behaviour. Health Promotion International, 10, 177-184.*
23. McNair DM, Lorr M & Droppleman LF (1992). *EdITS manual for the Profile of Mood States. San Diego, California: EdITS/ Educational and Industrial Testing Service.*
24. Millon T (Ed.) (1973). *Theories of Psychopathology and Personality. 2nd Ed. Philadelphia: WB Saunders.*
25. Millon T (1977). *Millon Clinical Multiaxial Inventory Manual (3rd Ed). U.S.A.: Interpretive Scoring Systems.*
26. Millon T (1986a). *A theoretical derivation of pathological personalities. In T Millon, & GL Klerman . Contemporary Directions in Psychopathology. New York: The Guilford Press.*
27. Millon T (1986b). *Personality prototypes and their diagnostic criteria. In T Millon, & GL Klerman. Contemporary Directions in Psychopathology. New York: The Guilford Press.*
28. Ogles BM, Masters KS & Richardson SA (1995). *Obligatory running and gender: An analysis of participative motives and training habits. International Journal of Sport Psychology. 26, 233-248.*
29. Yates A, Shisslack CM, Allender J & Crago M (1992). *Comparing obligatory to nonobligatory runners. Psychosomatics. 33, 180-189.*
30. Fields KB, Delaney M & Hinkle JS. (1990). *A prospective study of Type A behiavior and running injuries. Journal of Family Practice, 30, 425-429.*
31. van der Auweele Y, de Cuyper B, van Mele V & Rzewricke R (1993). *Elite performance and personality: From description and prediction to diagnosis and intervention. In RN Singer, M Murphy & LK Tennant, (Eds.). Handbook of Research on Sport Psychology. New York: McMillan.*
32. Vealey RS (1992). *Personality and Sport: A comprehensive review. In TS Horn (Ed.), Advances in Sport Psychology. Champaigne. Ill: Human Kinetics.*
33. Morris T (1995). *Psychological characteristics and sports behaviour. In T Morris & J Summers, Sports Psychology. Theory, Application and Issues. Brisbane: John Wiley & Sons.*
34. Regnier G, Salmela J, & Russell SJ (1993). *Talent detection and development in sport. In RN Singer, M Murphy & LK Tennant, (Eds.). Handbook of Research on Sport Psychology. New York: McMillan.* ☐

Psychological preparation for a low intensity marothon squash event

CJ Basson, MA, BEd, UED, Department of Psychology, University of Natal, Pietermaritzburg.

ABSTRACT

This case study describes the psychological preparation and intervention in a low intensity marathon event. A successful attempt was made on a world squash playing marathon record, and although the players were assisted by other professionals, it was decided to report the contribution of the psychological intervention. A holistic approach based on the individual needs of the players was designed, and the particular use and application of relaxation, imagery and re-interpretation of stimuli and responses is described. The application of various psychological intervention techniques is described in relation to their use to manage monotony, sensory habituation and sensory distortions, sleep and rest deprivation and team building. The aim of the case study is to provide practitioners with some guidelines for intervention in similar sporting events.

INTRODUCTION

Increasingly, sports scientists have recognised the important role that psychology can play in the preparation for low intensity marathon events. Investigations into the motivation of marathon runners[1], changes of mood states during and after marathon events,[2,3,4] and the effects of marathon events on sleep cycles,[5] have recently been reported in the literature. This paper describes selected psychological approaches used to prepare and support two elite squash players in their attempt to establish a world record attempt of 134 hours, in a squash marathon in August 1995. In addition to describing the psychological preparation, the article stresses the importance of a multi-professional approach to preparation and support.

Conceptualising the Intervention Approach

It is imperative that in a marathon event such as this, the psychological input needs to be approached in a multi-professional team context.[6,7] In addition to the clinical psychologist, the following professionals were involved with assisting in the preparation for, as well as assistance during the event: a biokineticist and exercise specialist; a sports physician, a team of physiotherapists; and a dietician. Although the main focus of this article is on the psychological intervention, this in no way detracts from the significance of the contributions of the other disciplines. It was agreed by the participating professionals that this particular aspect of the programme should be reported in greater detail.

Guiding principles for the intervention were based on the following behaviours that have been found to contribute to enhanced performance[8]: "intentionality, clear focus, total absorption in the task, effortless concentration, feelings of the body performing on it's own without fatigue, loss of fear, and certainty of success." Hardy[8] also mentions the success of programmes that train sport persons in the use of meta-cognitive skills, to assist the athlete in greater self regulation of affective, motivational and fatigue states in competition.

Additional theoretical support for guiding the choice of intervention strategies was taken from Richard Lazarus's[10] adaptational model of emotions, and Steven Apter's Reversal Theory. [11,12] The value of a cognitive-relational-motivational approach to intervention[10], lies in the fact that it emphasises the active role of adaptive problem solving in explaining emotional responses to particular environmental contexts. Apter's Reversal Theory,[11,12] was used to understand and plan for maintaining motivation in the event. The concepts, telic and paratelic metamotivational states, are used by Apter to refer to polarised states of motivational arousal between which an individual can shift. When in a telic state the individual is goal directed, serious minded and planful, and attempts to avoid arousal. Whereas in the paratelic state high arousal and immediate pleasure relating to the activity are evident, as are spontaneity and playfulness. According to Kerr,[12] an attitude of playfulness would engender natural curiosity, spontaneity and creativity in approaching such an arduous event, and thus enhance the enjoyment of the activity in itself. On the other hand telic states would assist in the more serious minded planning and goal directed problem solving necessary at times when future perspectives were necessary. In order to endure five days of continuous play with sustained motivation and interest in the activity, the players needed to be assisted to vary their motivational state between telic and paratelic states on a regular basis. The way in which arousal could be manipulated to enhance motivation and performance, was based on Kerr's[11] technique of meta-motivational reversal. By this he means that unpleasantly low or high arousal can be re-interpreted to the sports person, in order to change the direction of the arousal. This is similar to the technique of reframing used in family therapy.[14] Furthermore the related techniques of associative and dissociative mental strategies investigated by Schömer,[15] were also utilised.

In summary, the aim of the intervention was to provide the players with individualised psychological preparation and support in conjunction with a multi-professional team as well as a student support team. The primary focus being on the training of meta-cognitive skills, and relaxation techniques with associated mental imagery procedures. Most important, was to develop an overall attitude of playfulness towards the planning of, preparation for and participation in the event.

The Players

The participants in the marathon event were two male students studying on the Pietermaritzburg campus of the University of Natal, aged 24 (Player 1), and 20 years (Player 2). Player 1 is currently a PhD student and Player 2 an undergraduate student. Both players consider themselves to be ranked in the top 1-3 % of the squash players in the Natal Midlands region, and Player 1 has represented Natal, and could be regarded as being in the top 5-8 % players in the province.

Both players were highly motivated and goal oriented, with low overt anxiety levels throughout the preparation and performance phases. They had both previously participated in marathon events, Player 1 as a runner, and Player 2 as a canoeist and in the military.

Summary of Consultations with the Players

A summary of the psychological intervention with the players prior to and during the event follows:

In preparation:

1. Five interviews of approximately 1½ hours were conducted with the players, starting 12 weeks prior to the event.
2. Two weeks prior to the event, a trial game of 6 hours of play was arranged on the advice of the biokineticist. The psychologist attended for an hour session, and in this time he assisted the players to play "mindlessly" using relaxation techniques and guided imagery.
3. A group meeting of 1 hour was arranged with the student support team.
4. A follow-up session was conducted with both players.

During the event:

Twenty consultations of 10-20 minutes were held with the players on court while they were playing or resting, or during physiotherapy and or medical sessions. These consultations were usually conducted 4 times per day at 08:00, 12:00, 17:00, and 20:00. During this time the author rated the players on six, 5 point Likert type scales for affective valence, level of anxiety, goal directedness, reported fatigue, level of reported relaxation, and width of attention.

The Selection of Specific Skills

In the initial consultation with both players the proposed event was analysed with regard to the types of demands that it would make on them. The following areas emerged as focuses for psychological intervention:

1. The possibility of compromised motivation resulting from sensory habituation, monotony and boredom as a consequence of the reduction in novel sensory input during the marathon event.
2. Attending to fatigue and pain emanating from the repetitive use of the same muscles, tendons and joints over an extended period of time.
3. Management of sleep and rest deprivation due to the requirements of the record attempt. Two hours of rest a day, and 90 seconds rest between each game were prescribed.
4. The necessity of developing co-operative interaction and mutual support between the two players over an extended time period.
5. The development of effective communication with and between the members of the multi-professional and student support teams.
6. Accommodating the role of spectator behaviour in the performance.

After this initial consultation with the players, and consideration of relevant literature,[6,8,13,15,16] the following skills were identified as being important in addressing the problems identified above:

Goal-setting and planning
Mental imagery
Arousal control
Attention control
Attitude and problem reframing
Creative problem solving

Information that had been obtained from the players' consultations with the medical and paramedical team, was integrated into each psychological consultation session whenever it was appropriate. For instance, the information on diet was used in planning reinforcement schedules, while the information on possible medical problems and muscular problems was discussed relevant to relaxation and imagery. Furthermore, information from discussions that the players had had with the student support team, was used to plan creative solutions to potential sensory habituation and boredom problems.

Table 1, provides a brief summary of the content of the preparation sessions with the players and their student support team.

Table 1.
Summary of preparation consultations

SESSION NO	FOCUS
1	*Initial interview: Origin of the idea;* Motives; Intrinsic and extrinsic motivation; Response to failure and success; Goaldirectdness; Skill level; Interpersonal perceptions and supportiveness.
2	Start with the training in relaxation techniques using Jacobson's technique of progressive relaxation.Include guided imagery. Practice emphasised 1-2 x daily preferably before sleep.
3	Continue with relaxation training. Introduce autogenic training very successfully for both. Assistance in goal setting - short, medium and long term. Also assist in looking for rewards.
4	Continue with relaxation training and autogenic training. Talk briefly about their preparedness and the arrangements with the support team. Introduce creative problem solving for control of monotony, and encourage attitude of playfulness.
5	Full session on relaxation training. Goal setting reassessed.
6	6 hour trial game. Support on court by transferring relaxation techniques and guided imagery to *in vivo* experience.
7	Meet with student support group. Spell out the possible effects of the marathon, as well as the importance of the novel stimuli without coaxing and demanding performance.
8	Follow-up meeting with the two players to evaluate the experience and the impact of the event.

Mental preparation and intervention with the players
The abovementioned five target areas were selected as foci in the intervention programme. Each area will be discussed in relation to the preparation phase, and to the sessions on court respectively.

1. Monotony/Boredom/Sensory habituation

1.1 In a low intensity marathon event in excess of 130 hours, there is a high probability that monotony and sensory habituation would result from repetitive play in the insular environment of a squash court. Apart from physical fatigue, this aspect was regarded as one of the focal areas to attend to in the mental preparation of the players, as well as for orientation of the student support team. In order to address this problem, planning was done around introducing novel and varied sensory stimuli on and off court. In addition, the players were trained to utilise their paratelic states to develop an attitude of playfulness and creative problem management towards the attempt.[12] This was done by exploring ways in which they could focus on aspects of the event that would have intrinsic enjoyment for them. In addition, they were counselled to shift attention to pleasurable activities if and when they found themselves preoccupied with goal achievement activities only.
In preparation: Variations of auditory, visual and tactile stimuli were planned to ensure that the possibility of sensory habituation would be reduced. To maintain an element of surprise and novelty, some of these variations were known to the players and others were not. Some examples were: painting the court green, to introduce novelty and to reduce eye strain; using varying types of music and television programmes throughout the event, arranging to play against social and sporting celebrities; playing against squash development teams and schoolboy teams; playing on an adjoining court; taking hot and cold showers; focusing on the tactile experience of physiotherapy; changing clothes and footwear; walking on varying surface textures, etc. In planning this aspect, the players were encouraged to participate actively in finding creative and novel experiences that would in some way engage their humour and attention. This was in line with the playfulness referred to by Kerr.[12] The student support team played a significant role in preparing for this aspect of the event,. particularly with regard to planning novel events and food rewards.
On Court: Relaxation techniques and guided imagery were used to provide the players with skills to "escape" from the court using positive imagery. Metamotivational reversals were introduced to reinterpret out of the ordinary arousal states associated with perceptual distortions or emotional irritations occurring due to fatigue or sensory habituation. An example of this was when one of the players experienced visual distortions of the lines on the front and side walls of the court. The players and the support team had been advised that sensory phenomenon such as this could occur. He was assisted to exaggerate the distortions thereby heightening attentiveness to the stimuli and in so doing reduce the distortions. On the 4th day, the same player complained of the irritating and monotonous sound of the ball hitting the wall. Using a similar principle as above, he was encouraged to try to observe the ball closely to discover any patterns that it made on the wall when hit. His creativity lead him to discover, to his surprise, that the ball had a shadow and that he could predict the vector and trajectory of the ball depending on the shots he was playing. A novel visual stimulus had assisted him to defocus from the habituated auditory stimulus. Players were also taught to vary the pace of the game while in a relaxed state, which entailed sudden shifts from slow mindless play to rapid, hard hitting play.

1.2 Goal setting and rewards.
During the preparation phase, the players were assisted in setting short, medium and long term goals, that were consistent with their perceived needs and personal preferences. They chose food, physiotherapy, and monitoring of their heart rate and body mass at three-hourly intervals as specific rewards. The records of mass and pulse rate were displayed in graphic form at the entrance to the court, along with the full dietary sheet for the five days. This not only acted as a reward and motivation for the players, but also as a focus of interest for the support team and spectators.

1.3 Use of crowd support.
The court that was used was not glass-backed, thus limiting the novelty of crowd movement as a stimulus, to an upstairs gallery only. It was imperative to ensure that crowd support in the gallery was consistent and varied, and that it was used creatively by the players to reduce boredom. This was an extremely important aspect contributing to the continued motivation for the players throughout the entire five days of the event. The support team arranged a wide variety of social events at the venue to ensure a continuous flow of crowd support, especially in the early and late evenings.

2. Physical and Mental Fatigue and Pain
There was a distinct probability that pain, fatigue and overuse injuries could interfere with motivation and performance over a five day game. In addition to the competent medical and physiotherapy planning and support, psychological techniques to manage these eventualities were introduced.

The cognitive-behavioural literatures,[18] and the literature on psychological aspects of sport injury,[19] point to the use of, amongst others, relaxation techniques, imagery manipulation and acknowledging the painful experience and relabelling it.

In Preparation: The players were trained in the use of progressive relaxation techniques using a modified Jacobson approach, which was later combined with Schultz's autogenic training.[16] Deep breathing was used as a major facilitator of the relaxation training, as this technique is accessed with minimal effort while playing. Smith[17] also maintains that it is easier for sport persons to learn relaxation skills than cognitive control skills. The decision to use both techniques was informed by the different response that the two players had to relaxation and breathing techniques. Player 1 found the active mode of progressive relaxation more suitable, whereas, Player 2 preferred the passive mode of autogenic training and breathing.

In addition to the relaxation techniques, imagery rehearsal and guided imagery were used to cope with boredom and any stress that accrued due to fatigue or injury.

On Court: To further enhance the effectiveness of relaxation and guided imagery, the players were guided in *in vivo* practice of these skills during the trial play of 6 hours. This was done to encourage states of deep relaxation, and to defocus from the conscious motor action of play. This encouraged automatic "mindless" play as a means of maintaining motivation when pain and boredom were encountered. Relaxation and imagery were thus used while the players were in a telic state in which low arousal is viewed as motivating.[12] Brief sessions of this form of intervention were done once a day during the attempt under the supervision of the psychologist. The players were also encouraged to use this activity at times when they felt it was necessary to alter their motivational states. The players reported using their own creative variations of this technique, often mimicking the tone of voice of the psychologist as an aid in the process.

3. Sleep/rest deprivation

In terms of the rules of the attempt, the players were allowed 2 hours of sleep per day and 90 seconds of rest between each game. Campbell[20], points out that restricted sleep has minimal effects on physical performance, although Craig and Cooper[21], suggest that this effect is moderated by high motivational levels.

In Preparation: Relaxation techniques were used to ensure that the players fell asleep rapidly, and enjoyed a deep sleep in the two hours available. The players were encouraged to practice relaxation twice daily in the three months prior to increase the efficiency of their response to relaxation instructions. Sleeping arrangements were well planned to ensure consistency in the timing and the place of rest.

On Court: Relaxation techniques were used to ensure that the players could "rest" while playing, as well as to encourage automatic ("mindless") playing. They were also encouraged to use the relaxation techniques during the short rest periods between games, when eating and when receiving physiotherapy.

4. Interpersonal co-operation/Team building

In Prepation: During the consultations in the preparation phase, the players were assisted to clarify their own personal goals and motives for the attempt. They also discussed and clarified their expectations of one another, as well as their characteristic responses to failure, success, pain and boredom. They were encouraged to personally respond to this information in order that no "hidden agendas" should interfere with performance and coping. Furthermore, this could lead to greater understanding, and predictability of their partner's, and their own motives and behaviour during the course of play.

On Court: During the consultations on court, the psychologist was alert to any interpersonal tensions that may be present. If so, they were addressed and dealt with using appropriate supportive and interpretative psychotherapeutic techniques. This was particularly necessary with player 2, who on the fourth day of the event became irritable, was withdrawing and found the crowd support too demanding for him. Short sessions of crisis style counselling to locate the focus of the problem as well as a cognitive reframing of his relationship with the crowd, and accessing his well developed ways of coping were sufficient to shift the player to a more positive state.

He perceived the crowd as expecting him to perform for them, as he saw them having come especially to see him play. In reframing the problem, he was offered an interpretation that the crowd could be vicariously experiencing his pain and suffering to assess whether they themselves would be able to deal with it. The analogy of spectator behaviour at an accident scene was used to highlight the comparison. A redefined image of him being the suffering hero for the sake of the crowd was sufficient to engage the player in adopting a more positive attitude to the crowd, as well as placing less pressure on himself to perform.

5. Support for the multi-professional and student support team

One of the most significant aspects of preparation and performance was to ensure that the team of student helpers were well informed of the possible psychological effects of the marathon attempt. The team was briefed as to how to plan novel and interesting stimuli to ensure the maintenance of motivation. They were advised on the methods to use in motivating the players that would be beneficial to them. During the event the psychologist consulted with the members of the student support team to assess whether any support was necessary for them. While the players were receiving physiotherapy or medical attention, the psychologist was available for consultation with the professionals to assist them in dealing with any psychological consequences of fatigue and injury. This was particularly necessary on the day that Player 1 needed extensive medical treatment due to diarrhea and dehydration.

Discussion

The two players were successful in playing beyond the 133 hour limit to a new time of 134 hours. In the absence of any pre- and post-event evaluations, the discussion will focus on observations by the author, as well as on the follow-up interview with the players, with regard to the possible effects of the intervention on the success of the marathon attempt.

From observation of the players as well as from their own reports it was evident that the extent and intensity of crowd and student team support was instrumental in providing a context that was both supportive, distracting and stimulating. This factor appeared to have had an influence on levels of arousal and motivation, as well as on sustained goal directedness. The players reported that the games of squash played with celebrities and in particular, a group of schoolboys, had a very positive influence on motivation and levels of fatigue. This may be interpreted in the light of Kerr's[11] view on the reinterpretation of arousal states to enhance motivation and novelty.

Both players reported that the relaxation and guided imagery techniques had had a positive influence on their performance. In addition, the on-court sessions with the psychologist were found to be supportive, and enhancing and maintaining motivation and focus. The learnt ability of the players to engage in "mindless" playing, and to literally distract themselves by "going off the court in our minds", was of benefit in combatting fatigue and boredom. Both players reported that their explicit knowledge of each other's goals and motives, as well as the form of anticipated support from their partner, assisted in maintaining goal-directedness and motivation. This was particularly evident on day 2 when Player 1 developed chronic diarrhoea and had to be given medical attention, and the support of Player 2 was vital in maintaining a commitment to the completion of the event. In the latter stages of the event it became evident that Player 2 was relying on Player 1 to maintain his orderly playfulness and passion, and Player 1 depended on the inner centredness of Player 2.

In respect of the effects of sleep reduction on the performance of the players, they reported that this was not a major debilitating factor. The literature on the effects on performance,[5,20,21] suggest that high motivational states militate against the effects of sleep reduction and deprivation. In the light of the generally high levels of goal directedness of the players this may well have played some role in maintaining performance. There was, however, evidence of some motor effects in that Player 1 reported early morning body tremors that disappeared after about 20 to 30 minutes of waking. The onset of sleep was generally reported to be rapid, except for the first night where levels of cognitive arousal from the massive crowd support interfered with initial sleep, but did not recur on subsequent nights. Post event sleep patterns rapidly returned to normal within two days of the event. Both players reported perceptual disturbances on the 3 days following the completion of the event, in the form of exaggerated sense of acceleration when driving a motor vehicle, in the presence of actual slowing of the vehicle, i.e. they both experienced travelling very fast when in actual fact they were driving very slowly. In addition both reported heightened internal proprioceptive sensation. This may be evidence of a response to sensory sound habituation, that does have an effect on kinesis.

Both players had experienced the effects of marathon events in canoeing and running, and had sets of memories to retrieve for personal evaluation and prediction of the effects of the event. Their consistently high motivational levels and goal directedness were also possible contributors to the success of the intervention and the marathon event. Their observed response to fatigue and pain was invariably characterised by continued goal directedness and positive affect.

Conclusion

From this case study it appears that the areas of importance in preparing marathon athletes are the management of sensory habituation, fatigue and pain, the relationship between team members and the importance of crowd support. In particular, psychologists need to attend to varying sensory stimuli as a means of reducing the demotivating effects of sensory habituation in marathon events. Furthermore it would appear that teaching athletes to vary their motivational state between goal directedness and playfulness, may have the effect of sustaining interest over an extended period of time. The use of relaxation techniques and imagery were found to be beneficial to sustained motivation and performance, and was useful in varying and shifting attention when necessary. What was important was the continued supportiveness of a clinician to facilitate the ongoing use of learnt coping strategies, and to assist players in managing psychological states associated with sensory habituation. Apart from the success of the event, psychologists can use these events to investigate the demands that such an event will make on human psychological adaptation. It would have been of value to have conducted more rigorous assessments of perceptual, motor and neuropsychological and emotional-cognitivemotivational functioning during the course of the event as was done by other researchers in the field.[1,2,3,4,5]

References

1. *Masters KS & Ogles BM. An investigation of the different motivations of marathon runners. Journal of Sport Behavior. 18(1). 1990. 69-79.*
2. *Schömer HH & Dune TT. Emotional transitions of novice runners during a 7 month marathon training programme. International Journal of Sport Psychology. 25 (2). 1994. 176-186.*
3. *Tharion. WJ., Strowman. SR.. & Rauch.. TM. Profile and changes in moods of ultramarathoners. Journal of Sport and Exercise Psychology. 10(2). 1988. 229-235.*
4. *Douchamps-Riboux F. Heinz JK & Douchamps J. Arousal as a tridimensional variable: An exploratory study of behavioural changes in rowers following a marathon race. International Journal of Sport Psychology. 20(1). 1989. 31-41.*
5. *Edinger. JD.. Marsh. GR. McCall. WV.. & Erwin. CW. Daytime functioning and nighttime sleep before. during. and after a 146 hour tennis match. Sleep. 13(-16), 1990. 526-532.*
6. *Bakker. F.C.. Whiting H.T.A., & van den Brug. H. Sport Psychology: Concepts and Applications. New York: John Wiley & Sons. 1990*
7. *Turnbull. R.. Coetzee. D., & Mc Donald, T. Rugby Fitness Testing and Training. Pietermaritzburg: City Printing Works, 1995.*
8. *Hardy, L. Sport Psychology. In: Colman. A.M.. & Beaumont. J.G., (Eds.), Psychology Survey, 1989. pp 211-231.*
9. *Cratty. B. Psychology in Contemporary Sport. 2nd ed. Englewood Cliffs. New Jersey: Prentice Hall, 1973.*
10. *Lazarus. R. S. Emotion and Adaptation. New York: Oxford University Press. 1991.*
11. *Kerr. J.H. Anxiety, Arousal and Sport Performance: An Application of Reversal Theory. In: Hackfort. D., & Spielberger. C.D. (Eds) Anxiety in Sports: An International Perspective. New York: Hemisphere Publishing Corporation, 1989, pp 137-152.*
12. *Kerr. J.H. Sport: Work or Play. In: Kerr. J.H., & Apter. M. J. (Eds) Adult Play Amsterdam: Swets & Zeitlitiger. 1991. pp 43-53.*
13. *Jennings. K.E. Mind in Sport. Kenwyn: Juta. 1993.*
14. *Ivey. A.E.. Ivey. M.B.. & Simek-Morgan. L. Counselling and Psychotherapy: A Multicultural Perspective. 3rd Ed. Boston: Allyn Bacon. 1993.*
15. *Schömer. H. Mental Strategies and the Perception of Effort of Marathon Runners. International Journal of Sport Psychology. 17.41-59. 1986.*
16. *Bird. A.M.. & Cripe. B.K.. Psychology and Sport Behavior. St Louis: Times Mirror/Mosby. 1986.*
17. *Smith. R.E. Athletic Stress and Burnout: Conceptual Models and Intervention Strategies. In: Hackfort. D., & Spielberger. C. D. Anxiety in Sports: An International Perspective, New York. Hemisphere Publishing Corporation. 1989. pp 183-202.*
18. *Masters. J. C.. Burish. T. G.. Hollon S. D.. & Rimm. D. C. Behavior Therapy. New York: Harcourt Brace Javonovich. Publishers. 1989.*
19. *Heil. J. Psychology of Sport Injury. Champaign. Ill. : Human Kinetics. 1993.*
20. *Campbell, S.S. Effects of Sleep and Circadian Rhythms on Performance. In: Smith. A.P. & Jones. D.M.(Eds), Handbook of Human Performance. Vol 3. London: Academic Press, 1992, pp. 195-216.*
21. *Craig, A., & Cooper. R.E. Symptoms of Acute and Chronic Fatigue. In: Smith. A.P. & Jones. D.M.(Eds). Handbook of Human Performance. Vol 3. London: Academic Press. 1992, pp 289-339.*

Physiological, Kinematic & Psychophysical differences between Overground and Treadmill running

S Olivier,
Dept of Human Movement Science, University of Zululand.

ABSTRACT

In order to simulate overground walking and running, the motordriven treadmill is only used in physiological, kinematic and psychophysical studies of human emotion. Primarily because of the convenience and control that it offers, the treadmill has played an important role in the development of sports science and allied disciplines. However, the results of studies utilising the treadmill can only be extrapolated to overground situations if there are no demonstrable, significant differences between the two modes of locomotion. This paper serves to examine the literature in order to clarify the issues involved for researchers. The review indicates that while the treadmill is a convenient tool to assess responses to physical work, some caution should be applied when extrapolating certain kinds of data obtained under certain kinds of conditions. These might include kinematic variables at speeds in excess of 5 m.s^{-1}, using a treadmill for shoe or orthotic assessment, and for obtaining psychophysical measures, which depend to some degree on cognitive appraisal. When workloads are matched, it seems that measures of oxygen consumption are equivalent for the two conditions. Finally, researchers need to consider the issue of sufficient habituation to treadmill locomotion, as this may reduce possible differences when comparing the two modes of locomotion. In conclusion, the treadmill is a valuable tool in research investigating responses to physical work. Much of this research is however concerned with extrapolation to "real world" environments, and researchers should be aware of possible differences between the two modes of locomotion under certain conditions.

INTRODUCTION

The vast majority of research investigating physiological, kinematic and psychophysical responses to work appears to have been conducted in the somewhat artificial ambience of the laboratory. More specifically, the motordriven treadmill is frequently used in biomechanical and exercise physiology studies of locomotion, as well as for training and rehabilitation purposes. The treadmill offers many advantages to studies in human locomotion, mainly because of the control and convenience it offers, particularly when doing tests that require maximal effort. Using the treadmill, a familiar human movement can be varied in intensity while the subject performs in close proximity to metabolic and cardiorespiratory recording instruments.[1,2,3] As a result, the treadmill has played a very important role in the study of human movement.

The treadmill is often used to simulate overground walking and running, but the literature indicates a wide difference of opinion about the validity of the extrapolation of treadmill information to the overground environment or vice-versa[4]. Wall and Charteris[2] state that even though differences between the two conditions may exist, these are probably outweighed by the convenience offered by the treadmill. If however, significant differences do exist between the two modes of locomotion, the extrapolation of information from one environment to the other could involve inherent inaccuracies.

Therefore, it is important to examine the results of specific studies before the results of treadmill studies can be generalised to the field.

Kinematic factors

Initially it was thought that through a basic analysis of fundamental mechanics, the results of treadmill studies could be directly applied to the overground situation. That is, in a system involving movement relative to a surface, there is no difference whether a person moves over the surface or whether the surface moves beneath the person (except for the effects of air resistance). Several investigators have however found differences in the kinematics between treadmill and overground locomotion.[1,3,5,6] Nelson et al.[1] hypothesised that meaningful differences would be observed between the two conditions, indicating that different mechanics are utilised when running on the treadmill than when running overground under similar conditions of slope and speed. Performance conditions for the two running surfaces were duplicated, and there were no differences between the matched velocities. At 6.4 m.s^{-1}, longer stride lengths and lower stride rates were observed for treadmill running. The treadmill condition produced greater times of support and corresponding decreases for non-support (Table I).

Table I:
Mean results for stride length (m), stride rate (strides.s^{-1}), support and non-support (s); for horizontal running at 6.4 m.s^{-1}. (Table from data presented by Nelson et al. 1972)

	Stride length	Stride Rate	Support	Non-support
Overground	1.92	3.32	.162	.14
Treadmill	2.01*	3.1 5*	.1 75*	1.43

*Significant (p<.01)

Although horizontal velocity was matched for the two conditions, vertical velocity was greater for the treadmill condition, indicating that running on a stationary surface requires greater vertical velocity than running on a treadmill. The authors concluded that the difference in velocity was most likely due to the acceleration-deceleration pattern in overground running which develops during the driving phase (acceleration) and during the touchdown and recovery phases (deceleration). They further report that two interrelated running

Address for correspondence:
Private Bag X1001, KwaDlangezwa, 3886,
South Africa.
Telephone: 0351 93916 (work & fax), 921963 (a/h),
082 4525761
E-mail: solivier@pan.uzulu.ac.za

modifications occur on the treadmill. The runner's foot is placed further in front of the centre of gravity, and the moving belt returns the foot beneath the runner. In overground running this would lead to a retardation of velocity. All this increases duration of the support phase and decreases that of the airborne phase at a given velocity. In order for an adequate stride rate to be maintained however, the runner must complete the recovery and touchdown phases more rapidly.

Given the variability in vertical velocity, it was concluded that the work done would be greater for overground than treadmill running, and that there were significant biomechanical differences between overground and treadmill running, but that this was particularly so in the case of temporal variables. However, whether the differences observed in this study are of practical import is still an unresolved question. Elliott and Blanksby[5] found kinematic differences between the two conditions, but also only at higher velocities (4.82 - 6.2 $m.s^{-1}$). For both males and females during treadmill running, stride length decreased and stride rate increased, while the period of non-support was significantly less. Although the results of these two studies were contradictory in that at a common velocity athletes modified their running style in different ways, both investigators indicate that at a velocity of approximately 5 $m.s^{-1}$ or faster on the treadmill, modifications in locomotion are likely to occur, and this should be taken into account when extrapolating data to field situations.

Nigg et al[6] attempted to determine whether a treadmill can validly be used as an instrument to simulate the kinematics of human locomotion during overground running. Specifically, leg kinematics were quantified for treadmill running by varying the treadmill gradient, the running velocity, the shoe, and the experience with treadmill running and were compared with the corresponding values for overground running. They found that most of the lower extremity kinematic variables showed inconsistent trends for individual subjects, with the differences being substantial. Contrary to expectations, they found that an increase in running speed tended to decrease the kinematic differences, and that a larger, more powerful treadmill increased the differences. It must however be remembered that the number of subjects used to assess these questions was small (n=22) and the variance associated with the variables was quite high. In stressing the importance of treadmill habituation before extrapolating to overground conditions, and noting particular adaptations to treadmill locomotion, the authors concluded that individual assessments of running kinematics on a treadmill for shoe or orthotic assessment may possibly lead to inadequate conclusions about overground running.

Physiological factors

Frishberg[3] examined selected kinematic variables during overground and treadmill sprinting to determine possible physiological differences, as well as differences in running technique due to altered kinematic variables. He found that O_2 debt for the overground condition was 36% greater than for the treadmill running condition. Pugh[7] has proposed that at running velocities above 6 $m.s^{-1}$, air resistance might be responsible for such differences. The reported 36% increase in O_2 debt however, far exceeds other reports of the percentage cost of air resistance to energy expenditure, and as such the large difference cannot be accounted for purely by the air resistance factor. Frishberg's[3] kinematic analysis revealed a possible standardisation of running form during treadmill locomotion, and he concluded that his data suggested that overground and treadmill locomotion at high sprinting speeds are biomechanically different, and that this resulted in the significant difference in O_2 debt. He hypothesised that the moving treadmill belt reduces the energy requirements of locomotion by moving the supporting foot and lower leg backward, which may contribute to the observed greater range of angular motion displayed by the lower leg, as well as the reduced angular motion of the thigh during the support phase. These changes, he concluded, would probably result in a reduced workload for the hip musculature, thus requiring less energy expenditure for the treadmill running condition. Thus, according to this study, treadmill sprinting is not as physiologically stressful as overground running. Methodological problems with speed-matching between the two sprinting conditions however indicate that Frishberg's[3] results should be interpreted with caution. The validity of using O_2 debt to measure total energy expenditure is also questionable. Furthermore, the velocity differences between his and other studies makes comparison difficult.

McMiken and Danieis[8] measured VO_2, in a discrete series of three speeds and at maximal effort during treadmill and track running. The aerobic requirement differences were evaluated, and none of the differences were found to be significant. The authors concluded that if real aerobic differences do exist between the two conditions, then they are probably very small. They concluded that treadmill determinations of O_2 uptake may be validly extrapolated to track running in calm air. However, the running speed of subjects in this study never exceeded 4.3 $m.s^{-1}$, and differences may occur at higher velocities. In support of these results, Bassett et al[9] state that there is general agreement that the oxygen demand of level running is similar for both the treadmill and overground situations at speeds under 4.5 $m.s^{-1}$. As stated earlier, Pugh[7] reported a greater energy cost for track running, but this was attributed to the effects of air resistance rather than to fundamental differences in the mechanics of overground and treadmill locomotion. The question of whether real aerobic differences do exist between the conditions remains unanswered, but at present the treadmill appears to be a valid instrument for the estimation of oxygen uptake when the data are to be applied to track running in calm air at running speeds below 4.5 $m.s^{-1}$.

Most of the above studies were, however, conducted on level surfaces, and the issue of grade locomotion is an ergonomic problem that is far from resolved[10]. According to ACSM[11] prediction formulae, the energy cost for overground running is greater than for running on the treadmill. At a speed of 3.3 $m.s^{-1}$ and at 7.5% grade, the difference would amount to 10.25 $ml.kg^{-1} min^{-1}$. Conversely, Van Ingen Schenau[4] used a theoretical physics approach and concluded that there should be no differences between the metabolic energy requirements of inclined treadmill running and overground hill running. If differences do exist, Van Ingen Schenau[4] feels that they can be attributed to visual, and to a lesser extent, auditory factors. Bassett et al[9] report date which support these assumptions. At 0% and 5.7% grades, no significant differences were observed between overground and treadmill running. These conclusions are supported by the research of Olivier and Scott[12] (Table II), who found no differences in VO_2 for a grade running task on the treadmill and overground. Minute ventilation (VE) and psychophysical differences between the two conditions were attributed to cognitive appraisal of the particular work task. Visual information may be important in maintaining equilibrium and stability, while the ambience of the treadmill and laboratory could prove to be an extremely stressful environment for a subject. These factors together with wind resistance could cause differences between the two situations, but it appears that measurements of VO_2 obtained during level and inclined treadmill are valid when applied to the overground situation.

Psychophysical factors

With regard to possible psychophysical differences, an examination of several studies indirectly related to the problem will be useful. Utilising a parallel-processing perspective, Pennebaker and Lightner[13] demonstrated that during exercise, external cues (e.g. terrain) do compete with internal cues e.g. ventilation) specifically, despite no differences in fatigue ratings, subjects were found to run faster on a cross-country course than on a track. As fatigue reports were comparable for the two courses, it was hypothesised that shifting attention to external cues led to diminished responsivity to internal states.[14] Put another way, as subjects were focusing on external cues to a high degree on the cross-country course, their processing of internal sensations was restricted.[15] An investigation by Stones[16] provides some support for the limited capacity position described by Rejeski.[17] Stones[16] states that physiological control systems undoubtedly contribute to judgement of pace and fatigue, and it would be surprising if the visual system did not contribute also, at least to pace judgement. Consequently, his research was designed to increase the demand on a runner's visual system by restricting field of vision through the use of specialised goggles. Attenuated visual input resulted in: a) enhancement of perceived pace relative to actual pace, b) lessening of fatigue relative to actual pace, and c) slowing of actual pace. These findings make it apparent that the visual system, in addition to other physiological control systems, contributes to various aspects of the running experience. This raises an interesting question with regard to running environment and fatigue perception; namely, might parallel observations be obtained under conditions where visual input was not attenuated artificially? In other words, would runners on a treadmill report different perceptions of fatigue than when running outdoors at a similar pace? It is worth noting that under conditions of unrestricted vision, the visual field is filled both with near and far objects. For a person in motion, the corresponding retinal projections will therefore be associated with varying degrees of change.[16] This may not be the case for treadmill running. Stones[16] thus found that visual impairment and the subsequent vigilance required for movement resulted in reduced awareness of fatigue-relevant physiological information. Thus, according to this particular investigation, it would appear that what is available in perception can be blocked from consciousness by flooding the lines of communication with distracting stimuli.

Birk and Birk[18] contend that the use of Ratings of Perceived Exertion (RPE), estimated during exercise testing, to control intensity during training by reproduction of similar efforts, may be inappropriate. They feel that environment influences would render direct perceptual translations from the laboratory to the field invalid. Jackson et al[19] have demonstrated that the physiological and psychological correlates of exercise performance are different in a field setting than in the laboratory. On the other hand, ratings of perceived exertion were not affected by auditory input such as music and mechanical noise, e.g. treadmill operation.[20] It is worth noting that studies of this nature are difficult to control, and may not validly discriminate between the effects of physiological and psychological stress indicators, as has been inferred.[20] Nevertheless, in the field, where a myriad of social physiological forces impinge on the performer, the role of physiological feedback to RPE may well be reduced. The potential role that motivational and informational factors may play in the subjective assessment of physical work is thus increased.[14] This is supported by Olivier & Scott[12] (Table II), who investigated physiological (HR, VO_2, VE), perceptual (RPE) and attitudinal (Semantic Differential) responses to identically matched workloads (70% of VO_2 Max) under treadmill and overground conditions. There were no differences in VO_2 and HR responses, whereas VE and RPE responses were significantly elevated for the treadmill condition, and attitudes were more favourable towards the overground condition. In support of the literature cited above, the authors concluded that the differences were, at least in part, due to the perceptual and cognitive interpretations of the particular characteristics inherent in the two environments.

Table II:
Mean physiological, RPE and attitudinal responses to uphill (5.72%) overground and treadmill running at 2.94 m.s-¹. (Table from data presented by Olivier & Scott, 1993).

Variable	Overground	Treadmill
Physiological		
HR ($b.min^{-1}$)	157	156
VO_2 ($ml.kg^{-1}.min^{-1}$)	47.59	48.45
VE ($l.min^{-1}$)	69.05	75.13*
RPE		
Local	11.07	11.96*
Central	10.86	11.36
Overall	10.89	11.82*
Attitudes		
Evaluation	26.53	16.73*
Potency	16.64	13.91
Activity	18.27	16.81
Overall	61.46	46.82*

*Significant ($p<.05$)

Treadmill accommodation

Treadmill accommodation has been defined as the state obtained when a subject has had sufficient training on the treadmill, such that no significant within-day or between day kinematic or temporal differences are evident from stride-to-stride. The process involves the gradual establishment of a stable and essentially normal gait showing no significant variations in averaged kinematic patterns from stride-to-stride or trial-to-trial over days or weeks. Accommodation is contingent upon initial adjustment and subsequent long-term conditioning.[21]

Wall and Charteris[21] have demonstrated that the kinematics of treadmill locomotion alter as the novice learns how to walk on the moving belt surface. Although accommodation to the surface may initially be rapid, kinematic changes continue towards a stable gait pattern with distributed practice over a period of 1 hour.[2]

These authors have also suggested that there may be metabolic correlates of these progressive changes, and that changes in skill level may result in a lowering of the energy cost of gait as the novice becomes an accomplished treadmill walker. Furthermore, they recommend that when studies to investigate the subtle differences between overground and treadmill locomotion are contemplated, it would be inappropriate to employ subjects habituated for anything less than 1 hour, in several distributed practice sessions, and that measurements should not be taken during the first 2 minutes of performance.

Schieb[22] states that the actual time required before the individual feels comfortable with the treadmill seems to depend on factors such as length of time into the treadmill run and overground running experience, while Van Ingen Schenau[4] feels that psychological factors such as apprehension may retard accommodation. Therefore when the treadmill is used to derive cardiovascular measures in order to assign a subject's workload to the overground situation, it is important to expose the subject to an adequate amount of treadmill locomotion,[22] otherwise inaccurate or misleading information may result.

Investigating the problem of treadmill accommodation, Schleb[22] found that significant between-day kinematic adjustments were made by novice treadmill runners, but only between days 1-2 of a 10-day (15 min per day) training programme. Further, significant within-day adjustments were only evident between minutes 1 & 8 on any day's run, and not after minute 8. Within day differences were not found beyond the third day, indicating fairly rapid accommodation to treadmill locomotion.

From this he concluded that one 15 min training session is inadequate for a novice treadmill subject to accommodate fully, but that after the 8th min of a second habituation session a subject should be accommodated to the treadmill. Wall & Charteris[22] however suggest that where measurements are to be made of gait patterns for the purpose of application to overground situations, subjects should be previously habituated in distributed practice sessions for 1 hr, and no measurements should be made within the first 2 min of performance. Further, in studies investigating subtle differences between treadmill and overground conditions, it is inappropriate to utilise subjects habituated for anything less than 1 hr in several distributed practice sessions. However, when fine measures of gait are not collected, random speed and grade habituation of 10 min should suffice.[2]

Conclusion

In conclusion, the treadmill is a convenient tool to assess responses to physical work. In terms of its practical application as a research tool, it is widely used to extrapolate to overground locomotion contexts. The research reviewed above however indicates that some caution should be applied when extrapolating certain kinds of data obtained under certain kinds of conditions. These might include kinematic variables at running speeds in excess of 5 $m.s^{-1}$, using a treadmill for shoe or orthotic assessment, and psychophysical measures such as RPE and attitudinal responses, which depend to some degree on cognitive appraisal. There seems to be general agreement that measures of oxygen consumption are equivalent for both conditions when workloads are matched. Sufficient habituation to treadmill locomotion on the part of research participants may reduce the kinematic and psychophysical differences between the two conditions, with a consequent increase in the validity of applying the data to field situations.

References

1. *Nelson RC, Dillman CJ, Lagasse P & Bricket P (1972) Biomechanics of overground versus treadmill running. Medicine & Science in Sports 4(4), 233-240.*
2. *Wall JC & Charteris J (1981) A kinematic study of long-term habituation to treadmill walking. Ergonomics 24(7), 531-542.*
3. *Frishberg BA (1983) An analysis of overground and treadmill sprinting. Medicine & Science in Sports & Exercise 15(6), 478-485.*
4. *Van Ingen Schenau GJ (1980) Some fundamental aspects of the biomechanics of overground versus treadmill locomotion. Medicine & Science in Sports & Exercise 12(4), 257-261.*
5. *Elliott BC & Blanksby BA (1 976) A cinematographic analysis of overground and treadmill running by males and females. Medicine & Science in Sports 8(2), 84-87.*
6. *Nigg BM, De Boer RW & Fisher V (1995) A kinematic comparison of overground and treadmill running. Medicine & Science in Sports & Exercise 27(1), 98-105.*
7. *Pugh LGCE (1971) The influence of wind resistance in running and walking and the mechanical efficiency of work against horizontal or vertical forces. Journal of Physiology 213, 255-276.*
8. *McMiken DF & Daniels JT (1 976) Aerobic requirements and maximum aerobic power in treadmill and track running. Medicine & Science in Sports 8(8), 14-17.*
9. *Bassett DR, Giese MD, Nagle FJ, Ward A, Raab DM & Balke B (1 985) Aerobic requirements of overground versus treadmill running. Medicine & Science in Sports & Exercise 17(4), 477-481.*
10. *Charteris J (1986) Pedestrian adaptations to differences in the slopes of walking surfaces. Proceedings of the Second Annual Conference of the Ergonomics Society of Southern Africa, University of Cape Town.*
11. *American College of Sports Medicine (1980) Guidelines for Exercise Testing and Prescription. 2nd Edition, Lea & Febiger, Philadelphia.*
12. *Olivier S & Scott PA (1993) Physiological, perceptual and attitudinal responses to identically matched workloads in field and laboratory testing conditions. SA Journal for Research in Sport, Physical Education & Recreation 16(1), 63-72.*
13. *Pennebaker JW & Lightner JM (1980) Competition of internal and external information in an exercise setting. Journal of Personality & Social Psychology 39, 165-174.*
14. *Rejeski WJ (1981) The perception of exertion: a social psychophysiological integration. Journal of Sport Psychology 1981(4), 305-320.*
15. *Hardy CJ, Hall EG & Prestholdt PH (1986) The mediational role of social influence in the perception of exertion. Journal of Sport Psychology 8, 88-104.*
16. *Stones A (1980) Running under conditions of visual input attenuation. International Journal of Sport Psychology 11(3), 172-179.*
17. *Rejeski WJ (1985) Perceived exertion: an active or passive process? Journal of Sport Psychology 1985, (7), 371-378.*
18. *Birk TJ & Birk CA (1987) Use of ratings of perceived exertion for exercise prescription. Sports Medicine 4, 1 -8.*
19. *Jackson A, Dishman RK, La Croix S, Patton R & Weinberg R (1981) The heart rate, perceived exertion and pace of a 1.5 mile run. Medicine & Science in Sports & Exercise 13, 224-228.*
20. *Carton RL & Rhodes EC (1985) A critical review of the literature on ratings scales for perceived exertion. Sports Medicine 2, 198-222.*
21. *Wall JC & Charteris J (1 980) The process of habituation to treadmill walking at different velocities. Ergonomics 23(5), 425-435.*
22. *Schieb DA (1986) Kinematic accommodation of novice treadmill runners. Research Quarterly for Exercise & Sport, 57(1), 1 -7.*
23. *Charteris J (1987) Personal communication. Rhodes University, Grahamstown, South Africa.*