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ATTENTIONAL FOCUS AND ENDURANCE PERFORMANCE: REVIEW AND THEORETICAL INTEGRATION

USMERJANJE POZORNOSTI IN VZDRŽLJIVOST: PREGLED IN TEORETIČNA INTEGRACIJA SPOZNANJ

Abstract

The objective was to review research on attentional focus and endurance performance in the context of relevant theory. The purpose of this article is to present a theoretical integration of previous empirical findings and to offer theory-based directions for future research. A narrative review of experimental and correlational studies examining the relationship between attentional focus and endurance performance was conducted. The results showed that, for experienced athletes, associative strategies appear to be more effective than dissociative and control strategies. Only dissociation appears to be an effective strategy for inexperienced performers. These findings are consistent with the parallel processing model of Leventhal and Everhart (1979).

Key words: association, cognitive strategies, dissociation, perceived exertion

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Izvleček

Članek predstavlja pregled študij o usmerjanju pozornosti in vzdržljivosti v različnih teoretičnih okvirjih. Namen prispevka je predstaviti teoretično integracijo izsledkov dosedanjih empiričnih študij s tega področja in na podlagi teoretičnih spoznanj oblikovati smernice za nadaljnje raziskovanje. Pregledali smo eksperimentalne in korelacijske študije, ki preučujejo odnos med usmerjanjem pozornosti in vzdržljivostjo. Rezultati so pokazali, da so za izkušene športnike asociativne strategije usmerjanja pozornosti učinkovitejše kot disociativne in kontrolne strategije. Za neizkušene športnike pa je disociacija edina učinkovita strategija. Ta spoznanja so skladna z modelom vzporednega procesiranja avtorjev Leventhala in Everharta (1979).

Ključne besede: asociacija, kognitivne strategije, disociacija, zaznan napor

In 1977, Morgan and Pollock reported that elite marathon runners were using predominantly associative attentional strategies during competition, while non-elite marathoners were primarily relying on dissociative attentional strategies. Since Morgan and Pollock's seminal findings, many correlational (e.g., Durtschi & Weiss, 1986; Masters & Lambert, 1989; Silva & Appelbaum, 1989) and experimental (e.g., Clingman & Hilliard, 1990; Fillingim & Fine, 1986; Gill & Strom, 1985; Okwumabua, 1985; Padgett & Hill, 1989; Rejeski & Kenney, 1987; Saintsing, Richman & Bergey, 1988; Spink & Longhurst, 1986) studies have examined the relationship between attentional focus and endurance performance. Despite this empirical interest, the development of theory on the role of attentional processes in endurance performance has lagged (Masters & Ogles, 1998a). Therefore, the primary purposes of this article are to review the published literature on the relationship between attentional focus and endurance performance, to present a theoretical integration of previous empirical findings, and to offer theory-based directions for future research.

Before addressing the relationship between attentional focus and endurance performance, the theory and research on the role of attentional focus in the perception of pain, exertion and physical symptoms experienced during participation in endurance activities are reviewed in brief. As will be demonstrated, the link between attentional and perceptual processes is a logical point of departure for explicating the influence of attentional focus on endurance performance. First, however, definitions of key terms in this review are provided.

Definition of terms

In the context of endurance performance, attentional focus has generally been operationalised in terms of associative and dissociative attentional strategies. These strategies differ in terms of the direction and target of attention. Association refers to attention directed toward physical sensations and other task-related processes such as pace and competitive strategy, whereas dissociation refers to attention focused *away from* physical sensations and task-related processes (Morgan, 1978; Morgan & Pollock, 1977; Schomer, 1986).

Although researchers have used various terms for association (e.g., internal focus, attention, redefinition) and dissociation (e.g., external focus, distraction, avoidance), the operationalisation of these constructs has been fairly consistent (for exceptions, see Morgan [2001] and Rejeski [1992]). Even though association and dissociation are defined broadly and imprecisely (for a more detailed discussion of this issue, see Heil [1993] and Stevinson & Biddle [1998]), there are many regularities in the empirical findings. Thus, this review will retain the above definitions of association and dissociation.

Attentional focus and pain perception

Before sport and exercise scientists began systematically investigating the relationship between attentional focus and endurance performance, behavioural medicine researchers had been examining the effects of attentional strategies on pain perception for over a decade. Several reviews of this literature have been conducted (e.g., McCaul & Malott, 1984; Suls & Fletcher, 1985). In general, these reviews have supported the effectiveness of dissociative strategies compared to control conditions in which participants receive no attentional manipulation

(McCaul & Malott, 1984) and associative strategies (Suls & Fletcher, 1985) for coping with laboratory and clinical pain. An interesting exception to this conclusion is that associative strategies were found to be more effective than dissociative strategies when they involved focusing on the sensory aspects (as opposed to the emotional aspects) of a potential pain-inducing stimulus (Suls & Fletcher, 1985).

One implication of this finding is that an internal focus of attention directed toward physical sensations is neither inherently beneficial nor inherently deleterious for pain perception (Cioffi, 1991a). Associative strategies may be more effective than dissociative strategies if the individual is able to attend to the physical sensations in a relatively objective, non-emotional manner. If, however, the physical sensations are emotionally tinged and attention to these sensations is accompanied by a negative affect, attention directed away from the sensations (i.e., dissociation) may be the more effective strategy.

Leventhal and Everhart (1979) developed the parallel processing model of pain in part to explain inconsistencies in the relative effectiveness of associative and dissociative strategies. According to the parallel processing model, perceived pain is the end result of a process in which informational features (e.g., location, sensory qualities) and emotional components (e.g., feelings of distress and suffering) of the pain stimulus are encoded preconsciously to affect the construction of a percept that may or may not reach conscious awareness depending on the competition of cues in attentional channels. This model clearly states that the aversiveness of a pain stimulus is directly related to the extent attention focuses on the emotional aspects of the stimulus. Presumably, both associative and dissociative strategies are effective in decreasing the perception of pain by reducing the amount of attention centred on emotional reactions to the pain stimulus. This, of course, assumes that pain perception is a controlled attentional process and is therefore subject to the capacity limitations of short-term memory (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977). Although associative and dissociative strategies can be applied consciously, association is thought to operate at the preconscious level of processing by influencing the encoding and elaboration of the informational properties of the pain stimulus. Dissociation, on the other hand, functions by occupying limited attentional capacity with non-distressful cues (Rejeski, 1985).

Another aspect of the parallel processing model that is relevant to attentional focus is the hypothesis that pain perception is guided preconsciously by schemata (cognitive structures) representing the informational and emotional characteristics of previous pain experiences (Leventhal & Everhart, 1979; Pennebaker, 1982). Among the proposed functions of schemata are directing attention toward particular aspects of the pain experience, heightening sensitivity to specific stimuli, and facilitating adaptation to aversive situations (Leventhal & Everhart, 1979).

Attentional focus and perceived exertion

The relevance of the parallel processing model of pain (Leventhal & Everhart, 1979) to sport and exercise was noted by Rejeski (1985), who adapted the model to perceived exertion during physical activity. Rejeski proposed that the perception of exertion is influenced strongly by attentional processes and that attentional strategies (e.g., dissociation) may reduce exercise-related fatigue by occupying limited attentional resources. In adapting the parallel processing

model to perceived exertion, Rejeski also hypothesised that schemata, particularly affective schemata, can contribute to the perception of exertion during exercise.

Many experimental investigations that have manipulated attentional focus during the performance of an endurance task have included the rating of perceived exertion (RPE) as a dependent variable. In only a few of these studies, however, have participants' physiological workloads on the task been controlled (Johnson & Siegel, 1987, 1992; Russell & Weeks, 1994). Such control is needed to prevent the confounding of perceived and actual exertion.

Johnson and Siegel (1987) found, as would be predicted by the parallel processing model, that dissociation produced lower RPEs during a bicycle ergometer task than a control condition. Siegel, Johnson and Kline (1984) obtained a similar result using a work reproduction design. Using a bicycle ergometer task with female participants, Johnson and Siegel (1992) obtained no difference between a control condition and two dissociative strategies on RPE. This finding contradicts the parallel processing model in that diverting attention away from emotional cues failed to produce lower RPEs. In their investigation of trained male cyclists performing a bicycle ergometer task, Russell and Weeks (1994) found no significant differences in RPE among association, dissociation and control conditions. Johnson and Siegel (1992) did, however, find that participants using one of the dissociative strategies had significantly lower RPEs than participants using an associative strategy (association and the control condition did not differ). Although too few studies are available to draw any firm conclusions regarding the influence of attentional strategies on perceived exertion, the current evidence is only partially supportive of Rejeski's (1985) hypothesis.

A number of studies have examined Rejeski's (1985) contention that affective schemata may affect perceptions of exertion. Hochstetler, Rejeski and Best (1985) found that feminine-typed females had more negative pretask affects and gave higher RPEs during the latter stages of a 30-minute submaximal treadmill run (the physiological workload was constant across participants) than masculine-typed and androgynous females. These results, which were replicated with males on a bicycle ergometer task (Rejeski, Best, Griffith & Kenney, 1987), suggest that negative affective (or distress) schemata specific to physical activity accompanying the feminine sex-role orientation may serve as expectancies that heighten sensitivity to internal cues and, ultimately, elevate perceptions of exercise intensity (Rejeski, 1985).

Research has also shown that feminine-typed females have a greater pretask negative affect and give higher RPEs during an endurance task when exposed to an individual who displays exercise-related distress (Rejeski & Sanford, 1984). Similarly, Cioffi (1991b) found that male college students who had been instructed to monitor their physical sensations during a bicycle ergometer trial gave more negative interpretations of their sensations than no-instruction control participants when under conditions of threat (i.e., the possibility of receiving an electric shock during the trial), but gave more positive interpretations when there was no threat. The findings of Rejeski and Sanford (1984) and Cioffi (1991b) further illustrate the influence of cognitive sets on perceptions of exertion during endurance performance.

Attentional focus and endurance performance

The application of the parallel processing model (Leventhal & Everhart, 1979) for understanding the role of attentional focus in perceived pain and perceived exertion appears to have a solid

empirical base. In this section, building on the suggestions of Rose (1986), literature on the relationship between attentional focus and endurance performance from both experimental and correlational investigations help establish the generalisability of the model to the performance domain.

Experimental Studies

A number of experimental studies have investigated the effects of attentional focus on endurance performance. Unfortunately, it was impossible to perform a quantitative (i.e., meta-analytical) review because the majority of studies did not contain sufficient information to calculate effect sizes. Typically, these studies have used instructional sets to manipulate attentional focus. As shown in Table 1, the studies vary considerably in terms of sample size, endurance task, participants' task experience and attentional conditions. Even with these variations, the findings support several generalisations about attentional focus and endurance performance.

Although a superficial glance at Table 1 may suggest equivocal findings across studies, more interpretable results are revealed when the variable of participants' task experience is considered. Task experience is a central variable in the parallel processing model in that it contributes to the development of schemata that influence the perceptual experience during endurance performance (Leventhal & Everhart, 1979; Pennebaker, 1982; Rejeski, 1985). For participants who were inexperienced with the endurance task, dissociative strategies were more effective than associative and control strategies in 5 of the 11 studies (Gill & Strom, 1985; Pennebaker & Lightner, 1980; Rejeski & Kenney, 1987; Spink, 1988; Weinberg, Smith, Jackson & Gould, 1984, Experiment 2). Even when dissociation was not more effective than association and control conditions for inexperienced participants (Couture, Jerome & Tihanyi, 1999; Fillingim & Fine, 1986; Fillingim, Roth & Haley, 1989; Okwumabua, Meyers, Schleser & Cooke, 1983; Saintsing, Richman & Bergey, 1988; Scott, Scott, Bedic & Dowd, 1999; Wrisberg, Franks, Birdwell & High, 1988), dissociation was *no less* effective than other strategies in all studies, except two (i.e., Saintsing et al., 1988; Scott et al., 1999).

For participants who were experienced with the endurance task, however, association was more effective than dissociation in four of the five studies where direct comparisons were made (Clingman & Hilliard, 1990; Connolly & Janelle, 2003, Experiment 1, Experiment 2; LaCaille, Masters & Heath, 2004; Spink & Longhurst, 1986). No significant effects were obtained in the fifth study (Weinberg et al., 1984, Experiment 1). With the exception of the Weinberg et al. study, support for the effectiveness of association (Rushall, Hall, Roux, Sasseville & Rushall, 1988; Rushall & Shewchuk, 1989) and dissociation (Morgan, Horstman, Cymerman & Stokes, 1983; Padgett & Hill, 1989) over control strategies for experienced participants has been found.

Although too few experimental studies have been conducted to reach definitive conclusions about the effects of attentional focus on endurance performance (Masters & Ogles, 1998a), the available evidence is consistent with a parallel processing (Leventhal & Everhart, 1979) interpretation. Assuming that emotional distress compromises endurance performance (Williams, Krahenbuhl & Morgan, 1991), one would expect that those strategies that direct an endurance athlete's attention away from such distress would improve performance. This may account for the success of dissociative strategies relative to control strategies for both experienced and inexperienced performers.

Table 1: Experimental investigations of the effects of attentional focus on endurance performance

Study	N	Task	Task Experience[a]	Conditions[b]	Significant Results
Clingman & Hilliard (1990)	16	0.5 mile racewalk	E	A_1A_2D	$A_1 > DA_2$
Connolly & Janelle (2003)					
Experiment 1	9	20 min rowing ergometer trial	E	AD	A > D
Experiment 2	24	2000 m rowing ergometer trial	E	$A_1A_2D_1D_2$	$A_1A_2D_1 > D_2$
Couture et al. (1999)	69	500 m swim	I	AD_1D_2C	A > C
Fillingim & Fine (1986)	15	1 mile run	I	ADC	--
Fillingim et al. (1989)	60	bicycle ergometer tolerance ride	I	D_1D_2C	--
Gill & Strom (1985)	34	leg extension tolerance	I	AD	D > A
LaCaille et al. (2004)	60	5 km run	E	AD	A > D
Morgan et al. (1983)	27	treadmill tolerance walk	E	DC	D > C
Okwumabua et al. (1983)	31	1.5 mile run	I	ADC	--
Padgett & Hill (1989)	12	1 mile run	E	D_1D_2C	$D_1 > C$
Pennebaker & Lightner (1980)[c]	13	1800 m run	I	AD	D > A
Rejeski & Kenney (1987)	60	hand dynamometer tolerance	I	D_1D_2C	$D_1D_2 > C$
Rushall et al. (1988)	18	2 X 70-130 sec cross country ski	E	AC	A > C
Rushall & Shewchuk (1989)					
Experiment 1	6	400 m swim	E	AC	A > C
Experiment 2	6	8 X 100 m swim	E	AC	A > C
Saintsing et al. (1988)	50	1.5 mile run	I	ADCO	A > DOC
Scott et al. (1999)	9	40 min rowing ergometer trial	I	AD_1D_2	$A > D_1D_2$
Spink (1988)	36	leg extension tolerance	I	D_1D_2C	$D_1 > D_2C$
Spink & Longhurst (1986)	23	400 m swim	E	AD	A > D
Weinberg et al. (1984)					
Experiment 1	60	30 minute run	E	ADCO	--
Experiment 2	230	leg extension tolerance	I	ADCO	DO > AC
Wrisberg et al. (1988)	20	treadmill tolerance run	I	AD	--

[a]Participants were categorised as either experienced (E) or inexperienced (I) with the task on the basis of descriptions of the participants and procedures in the original articles.

[b]A = association; D = dissociation; C = control; (A+D) = combined association/dissociation; O = other. Subscripts indicate multiple associative or dissociative conditions.

[c]Attentional focus was manipulated in this study not by instructions, but rather by having participants run on a track (association) and on a cross country course (dissociation).

From a parallel processing perspective (Leventhal & Everhart, 1979), association should prove an effective strategy for experienced athletes and a counterproductive strategy for inexperienced athletes. Experienced athletes, who have habituated to the rigours of endurance activity through training, should be able to interpret bodily sensations in an objective, non-emotional manner. Conversely, because objective sensory schemata, free of negative affect/distress, take

time to develop (Leventhal, 1982), inexperienced athletes should interpret sensations inherent in endurance activities (e.g., pounding heart, muscle fatigue) in an emotional, distress-provoking manner. The findings from the extant experimental literature support this theory-based hypothesis.

The apparent superiority of association over dissociation for experienced participants can be understood in terms of the task-relevance of the locus of attentional focus. Although both associative and dissociative strategies divert attention from distress cues, the content of associative strategies (e.g., bodily sensations, pace, competitive tactics) may be more useful in enhancing endurance performance than the content of dissociative strategies (e.g., task-irrelevant cognitions).

Correlational Studies

Whereas experimental studies of the relationship between attentional focus and endurance performance have used a variety of endurance tasks, correlational studies have concentrated on marathon running. Investigations with marathon runners as participants have largely supported the Morgan and Pollock (1977) finding that elite marathoners use associative strategies to a greater extent than non-elite marathoners. Studies by Masters and Lambert (1989) and Silva and Appelbaum (1989) found the use of associative strategies to be positively correlated with marathon performance. These findings are bolstered by the significant positive correlation between sensitisation (of the repression-sensitisation personality dimension), which is conceptually similar to association, and marathon performance obtained by McKelvie, Valliant and Asu (1985). Although both Schomer (1986) and Durtschi and Weiss (1986) found no difference in the use of associative strategies by elite and non-elite marathon runners, Durtschi and Weiss did find that non-elite marathon runners were more likely than elite marathon runners to report using dissociative strategies. Similar to the findings of Durtschi and Weiss, Masters and Ogles (1998b) found that marathon runners who tended to report using dissociative strategies showed poorer performance levels than those who tended to report using associative strategies. Finally, Okwumabua (1985) found no relationship between the use of association and marathon performance, but did find that using association was positively related to longer training runs and faster marathon goal times.

In the few correlational studies that have not involved marathon runners a less consistent pattern of results has emerged. Okwumabua et al. (1983) found that novice runners who reported using dissociative strategies ran faster in a 1.5 mile run than novice runners who reported using associative strategies. Similarly, Wrisberg and Pein (1990) found that experienced recreational (as opposed to competitive) runners tended to use dissociation and that inexperienced recreational runners tended to use association. The findings of Okwumabua et al. (1983) and Wrisberg and Pein (1990), however, contrast with those of Brewer, Van Raalte and Linder (1996), who found that intercollegiate cross country runners indicated that they would use association to a significantly greater extent and dissociation to a significantly lesser extent than introductory students on a maximal effort endurance run. Self-reported use of association was also related to a better performance in a 12-minute stairclimbing task in this study (Brewer et al., 1996). Although no significant differences in the use of associative and dissociative strategies emerged in a study of triathletes, runners and swimmers across three levels of competition (i.e., national, regional, departmental; Antonini-Philippe, Reynes & Bruant, 2003), it was found in a study by Baker, Côté and Deakin (2005) that high-level

ultra-endurance triathletes reported attending to task-related thoughts during competition than mid- and low-level ultra-endurance triathletes.

For the most part, findings from correlational studies dovetail nicely with those from experimental studies. The use of association has generally been related to better endurance performance. In accord with hypotheses derived from the parallel processing model (Leventhal & Everhart, 1979), dissociation appears to be used more frequently by non-elite athletes than by elite athletes and appears to be more effective than association among novice performers. This inference, of course, is based in part on the assumption that elite athletes generally have more experience with the endurance task than non-elite athletes.

As hypothesised above, the apparent superiority of associative strategies in endurance performance may be because these strategies are highly task-relevant and are more likely to be employed by experienced competitive athletes (Masters & Lambert, 1989). Elite/non-elite differences in the reported use of association aside, competition in endurance events tends to bring out the use of association across levels of performance. Many studies have indicated that endurance athletes use associative strategies to a greater extent than dissociative strategies during competition (Freischlag, 1981; Masters & Lambert, 1989; Morgan, O'Connor, Ellickson & Bradley, 1988; Morgan, O'Connor, Sparling & Pate, 1987; Newsham, Murphey & Tennant, 1992; Newsham et al., 1991; Ogles, Lynn, Masters, Hoefel & Marsden, 1993-1994; Okwumabua, 1985; Summers, Sargent, Levey & Murray, 1982; Ungerleider, Golding, Porter & Foster, 1989). Similarly, Morgan et al. (1988) found that a sample of elite male distance runners used association significantly more during their races than during training runs. Bachman, Brewer and Petitpas (1997) elaborated on the results of the Morgan et al. (1988) study, documenting that the association levels of intercollegiate cross country runners were higher for a race than for an easy training run but no different for a race and an interval workout (which involved running short distance repetitions at a fast pace). Collectively, these findings suggest that, when endurance athletes want to maximise competitive performance, they associate. This preference may be attributable to the task-relevant content of associative strategies. It is also possible, however, that the greater physical exertion and concomitant body sensations involved in competition rather than competition *per se* produces an inward focus of attention (Bachman et al., 1997; Schomer, 1986; Tammen, 1996).

Conversely, when endurance athletes are training, and the performance outcome is less critical, dissociation seems to be the preferred strategy. A number of studies have documented the greater use of dissociative strategies relative to associative strategies during training for endurance events (Masters & Lambert, 1989; Morgan et al., 1987; Ogles et al., 1993-1994; Orlick, Power & Partington, 1980a, 1980b; Sachs, 1984; Summers et al., 1982). In their sample of elite male distance runners, Morgan et al. (1988) found that dissociation was used significantly more during training runs than during races. Extending the findings of Morgan et al. (1988), Bachman et al. (1997) found that the use of dissociative strategies tended to increase as the degree of competitive intensity (and presumably the level of exertion) involved in the run decreased. Thus, dissociative strategy use was most prevalent in an easy training run, at an intermediate level in an interval workout, and least prevalent in a race (Bachman et al., 1997). Because the stakes are lower in training than in competition, endurance athletes may dissociate to take a 'mental breather' or to make productive use of their training time (e.g., solving problems, thinking about personal or occupational concerns).

Summary

Data from experimental and correlational investigations of the relationship between attentional focus and endurance performance have provided tentative support for the predictions generated by the parallel processing model (Leventhal & Everhart, 1979). Both association and dissociation can be effective in enhancing endurance performance. Nevertheless, the value of association appears to be contingent on having sufficient experience with the endurance task so that the monitoring of bodily sensations can occur in an objective, non-emotional manner. Further research is needed to verify and explicate these tentative conclusions.

Recommendations for future research

One advantage of applying the parallel processing model (Leventhal & Everhart, 1979) to the study of attentional focus and endurance performance is that the model is a source of many testable hypotheses. For example, there is clear theoretical basis for the prediction that association is more effective than dissociation for experienced participants and that the reverse is true for inexperienced participants. The extant literature, consisting of an aggregation of studies dealing primarily with only one level of task experience, supports this hypothesis. Nevertheless, the critical design to examine the crossover interaction prediction remains untested. A single study is needed that manipulates both attentional focus (association/dissociation) and participants' task experience.

Similarly, given the centrality of schemata to the parallel processing model (Leventhal & Everhart, 1979; Pennebaker, 1982), research investigating schema development is needed. The cross-sectional findings of Hardy and Rejeski (1989, Experiment 2) suggest that experience with endurance tasks reduces negative affective responses to physical exertion. Okwumabua et al. (1983) found that inexperienced runners became increasingly associative with training. The longitudinal findings of Noble, McCullagh and Byrnes (1993) indicated that the negative correlation between ratings of perceived exertion and affect became weaker as participants gained experience with endurance tasks. Studies such as these are essential to understanding how schemata develop and moderate the effects of attentional focus on endurance performance.

Another important avenue for future research is to test the hypothesis that strategies requiring greater attentional capacity (thus diminishing the emotional reaction to exertion) are more effective than strategies occupying less attentional capacity (McCaul & Malott, 1984). Initial inquiries in this area have not supported the attentional capacity hypothesis (Fillingim et al., 1989; Rejeski & Kenney, 1987; Siegel, Johnson & Davis, 1981). Similar subsequent findings may have important ramifications for the validity of the information processing assumptions (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977) underlying the parallel processing model (Leventhal & Everhart, 1979).

From a conceptual standpoint, further refinement in the definitions of association and dissociation may be warranted. Heil (1993) argued in favour of a 2 x 2 pain-sport attentional matrix in which association and dissociation in relation to pain are crossed with association and dissociation in relation to sport to create four separate attentional strategies (i.e., pain association/sport association, pain association/sport dissociation, pain dissociation/sport association and pain dissociation/sport dissociation). Similarly, Stevinson and Biddle (1998) proposed a

2 x 2 matrix in which a task relevance dimension (association, dissociation) is crossed with a direction of attention dimension (inward, outward) to produce four independent strategies (i.e., inward monitoring, outward monitoring, inward distraction, outward distraction). Heil's framework has not yet been examined empirically, while research in which the Stevinson and Biddle definitional scheme has been used has yielded equivocal results (Connolly & Janelle, 2003; Stevinson & Biddle, 1998). Nevertheless, further inquiry on association and dissociation from a multidimensional perspective may prove fruitful.

It may be of both theoretical and practical significance for researchers to explore the mechanisms by which attentional focus affects endurance performance. As suggested above, association may be more effective than dissociation in enhancing endurance performance in experienced athletes because of its greater task-relevance. In order to determine how this greater task-relevance produces elevated performance, it may be useful to adopt a multidisciplinary approach as advocated by Crews (1992). Perspectives and methods from biomechanics (e.g., Kenney, Rejeski & Messier, 1987), physiology (e.g., Harte & Eifert, 1995; Hatfield, Spalding, Mahon, Slater, Brody & Vaccaro, 1992; Martin, Craib & Mitchell, 1995; Smith, Gill, Crews, Hopewell & Morgan, 1995; Tammen, 1996) and neurology (e.g., Miron, Duncan & Bushnell, 1989) can contribute to the study of attentional focus and endurance performance. For example, Hatfield et al. (1992) found that trained runners performing a treadmill running task demonstrated better ventilatory efficiency under an associative condition than under dissociative and control conditions.

Although the main conclusions of this review imply that attentional strategies can, in certain conditions, enhance endurance performance, the potential limitations of such strategies need discussion. Boundary conditions for using attentional strategies need to be specified. There is reason to believe, for example, that the impact of attentional and other cognitive factors may attenuate when internal bodily cues are highly salient (Hardy, Hall & Prestholdt, 1986; Rejeski, 1981; Rejeski & Ribisl, 1980). Thus, the effects of attentional strategies may be larger for longer endurance events, in which the intensity of physical exertion is lower than for shorter endurance events.

Another potential limitation of using attentional strategies is that they may increase the risk of injury. Morgan (1978) hypothesised that excessive use of dissociation may produce injury because athletes may overextend themselves as a result of diverting their attention from physical warning signals. Preliminary empirical data have not supported this hypothesis (Bond, Miller & Chrisfield, 1988; Masters & Lambert, 1989; Masters & Ogles, 1998b; McKelvie et al., 1985; Ungerleider et al., 1989). In fact, individuals who associate may be at greater risk for injury than individuals who dissociate because, as a function of being more competitive (Masters & Ogles, 1998b; Masters, Ogles & Jolton, 1993), associaters may push themselves harder and therefore incur more injuries. Further research is needed to determine whether attentional strategies *per se*, rather than competitiveness and harder training, are related to injury risk.

Finally, there are a number of methodological considerations that are crucial for future research. Whenever possible, experimental research should incorporate standard protocols. Similar instructional sets (e.g., association, dissociation) across studies are useful for comparing results. Training participants to use the attentional strategies under investigation (Schomer, 1987) helps to ensure that participants' subsequent endurance performance is affected by

attentional focus instead of the novelty of the situation. Attentional strategy manipulation checks are needed to evaluate the integrity of attentional manipulations (Masters & Ogles, 1998a). In field research, there is a clear need for standardised instruments to assess attentional focus during the performance of endurance tasks (Masters & Ogles, 1998a). Several running-specific measures of attentional focus have been developed, including the Running Styles Questionnaire (Silva & Appelbaum, 1989), the Attentional Focus Questionnaire (Wrisberg & Pein, 1990), the Thoughts During Running Scale (Goode & Roth, 1993), the Thinking Styles Questionnaire (Ogles et al., 1993-1994) and the Attentional Focusing Questionnaire (Brewer et al., 1996). In addition to questionnaires, audio (Schomer, 1986) and video-enhanced (Baker et al., 2005; Blackburn & Hanrahan, 1994; Stoll, 1993) attentional focus assessment methods are available. Attempts to take into account the fact that attentional strategies rarely remain constant and are likely to shift frequently during endurance events will help make future studies more ecologically valid (Couture et al., 1994; Laasch, 1994-1995; Masters & Lambert, 1989; Newsham et al., 1991; Sachs, 1984; Sacks, Milvy, Perry & Sherman, 1981; Silva & Appelbaum, 1989; Tammen, 1996).

Attentional focus appears to be an important variable in endurance performance. Although the parallel processing model (Leventhal & Everhart, 1979) clearly offers a useful framework for investigating attentional focus and endurance performance, other theoretical formulations such as that proposed by Tenenbaum (1996) also warrant consideration. Research addressing hypotheses grounded in theory should promote a fuller understanding of the ways attentional processes influence endurance performance. The application of findings from the line of research in this area should also contribute to the enhancement of endurance performance.

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