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Motor Behavior Literature Fails to Translate: A Preliminary Investigation into Coaching and Focus of Attention in Recreational Distance Runners

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ABSTRACT

International Journal of Exercise Science 13(5): 789-801, 2020. The benefits of using an external focus relative to an internal focus for endurance activities are well documented. However, literature has revealed that internally focused instructions are predominantly adopted in the field, and existing data are limited to highly-skilled level populations. Moreover, athletes' focus of attention during fatigue invoking activities is unknown. The purpose of the current study was to examine what type of feedback and instructions experienced recreational individuals receive and their self-adopted focus of attention when fatigued. Distance runners answered a questionnaire related to instruction and feedback from coaches and thoughts that the athletes experienced while fatigued. The results showed that more than half of the instructions runners received from coaches were internally focused and consisted of both knowledge of performance and knowledge of results. Self-reported focus of runners when fatigued revealed that only 15% of task-related thoughts were externally focused. Despite a large body of motor behavior literature, attentional strategies shown to increase performance and learning were not predominantly present (from coaches or self-adopted) for this population of experienced recreational distance runners.

KEY WORDS: Attentional focus, endurance activity, motor learning, associative and dissociative attention, external and internal focus of attention.

INTRODUCTION

Various instructional techniques have been investigated to facilitate motor learning and performance for performers and coaches. One of the primary forms of these techniques is verbal instructions or cues (17). Verbal cues facilitate learning of motor skills by directing performers' focus of attention (attentional focus) to an important aspect of the skill. Researchers in attentional focus have categorized different types of attentional foci (2, 3, 22). In motor behavior, the large body of literature has investigated two different attentional foci that direct performers attention to different aspects of skills. An *external focus* directs a performer's attention to the effects of their movements on the environment (e.g., "focus on minimizing the movement of the

board" in balancing on a board) and an *internal focus* directs attention to body movements (e.g., "focus on minimizing the movement of your feet") (44). Complementary studies have also operationally defined an external focus as attention directed towards the environment and an internal focus as attention directed toward the movement itself (35, 37). Even with this subtle manipulation of verbal cues, studies indicate the superior effect of an external focus for tasks including balance (19, 44), accuracy (16, 28, 47), and explosive movements (10, 41). The constrained action hypothesis has been used to explain these attentional focus effects (19, 43, 44), proposing that an internal focus disrupts movement fluidity. For example, studies using electromyography have shown internal focus adds "noise" to the muscular activity and poorer performance (16, 47), which is indicative of inefficient neuromuscular coordination. This has also shown in endurance activities, including running (34, 35) and rowing (36), showing that an internal focus resulted in poorer physiological efficiency.

The benefits of external focus have also been demonstrated when attentional focus cues are provided after performance—defined as augmented feedback. When augmented feedback provides information pertaining to *movement quality*, this is defined as knowledge of performance (KP). In contrast, when augmented feedback contains information pertaining to *performance outcomes*, this is defined as knowledge of results (17). For instance, providing a distance runner augmented feedback about the motion of their arms and legs, this would be defined as KP; whereas providing augmented feedback about their total time to complete a race would be deemed KR. As we integrate the two different motor behavior concepts, KR is generally externally focused (e.g., directing a runner's attention towards their time on a scoreboard); whereas KP could be internally or externally focused. For example, telling a runner, "distribute your step landings more evenly *over the ground*," is considered externally focused KP; whereas telling a runner, "distribute your body weight more evenly *throughout each foot*" would be considered internally focused KP. Although research in this paradigm has historically emphasized the effects of frequency, timing, and the retention effect of augmented feedback (32, 33), recent research has shown that augmented feedback enhances skill acquisition when the cues are externally focused (whether KP or KR) (38, 43, 46).

Despite these laboratory findings of the external focus benefits, qualitative studies have reported that athletes, including baseball players (40), dancers (12), and golfers (8), predominantly adopt internal focus cues. One potential reason for athletes adopting internal foci is because their coaches provide internal focus cues or augmented feedback (8, 13, 25). These findings may indicate the impact of coaches' verbal cues and augmented feedback have on athletes' attentional focus. Interestingly, recent studies have revealed that the proportion of internal and external foci that athletes adopt (11) or coaches provide to their athletes (9) is sport- and situation-specific. Furthermore, although a different category of attentional focus, previous research has been clear that mental techniques and attention that athletes use vary by skill levels (22, 29). These findings suggest that the optimal attentional focus instructions or augmented feedback may be different for different sports and skill levels. However, research in the external/internal focus paradigm has been predominantly conducted in elite level athletes (8, 9, 11, 13). Considering more than 18 million recreational runners register marathon races each year (30), literature lacks the nature of attentional focus in the recreational or recreational level

athletes. Finally, the majority of the sport population is at recreational levels, warranting further investigation of the attentional focus component in verbal cues and augmented feedback to understand how to maximize performance in these populations.

The external/internal focus paradigm also lacks qualitative research during endurance activity. While quantitative studies have shown that external focus can improve physiological efficiency (35, 36), there are inconsistent findings (21), and other lines of research have questioned the efficacy of various cognitive techniques to improve endurance-based tasks (6,15). The difficulty in ascertaining the optimal form of attention to maximize endurance-based activities may stem from the lack of knowledge regarding the type of focus athletes adopt when fatigued. Studies in associative (directing attention to the task-relevant cues) and dissociative (directing attention away from the task-relevant cues) attention (22) have demonstrated attentional shifts caused by fatigue (7, 25, 34, 39). Accordingly, the optimal attentional focus strategy for runners at the beginning of a race (less fatigue) may be different at the end of a race (more fatigue). However, research studies have primarily been interested in optimizing which type of associative or dissociative attention is superior (7, 14, 24), thus are limited in their understanding for the optimal attentional strategy for both associative/dissociative and internal/external focus when runners are fatigued (27). Therefore, integrating both categories of attentional focus may reveal a complex nature of attentional focus shifts when runners are fatigued.

As coaches' verbal cues and augmented feedback may affect performers' attentional focus, research has revealed the type of attentional focus verbal cues and augmented feedback that coaches provide to their athletes (8, 25). However, the type of attentional focus verbal cues and feedback are sport- and skill level specific (9, 22) and recreational level runners' attentional focus is still unknown. The first purpose of the present study was to examine verbal cues and the type of augmented feedback that recreational runners receive from their coaches. This question was examined by adapting a questionnaire from previous studies (8, 25) for use in recreational runners. Additionally, research has shown that fatigue affects runners' focus of attention (7, 25), but how fatigue affects attentional focus has been examined only in the associative/dissociative attention paradigm (34, 39) or has not been examined in the external/internal focus paradigm. Thus, our secondary purpose was to understand both associative/dissociative and external/internal focus when runners are fatigued. This question and results were categorized into multiple types of attentional foci of task-relevant and irrelevant attention. The rationale of adopting this method was that athletes' attention is more complex than dichotomous category of attention (4, 5). Thus, the present study combined associative/dissociative and external/internal focus with other thoughts process (4, 5), using the same method adopted in the previous study (27).

METHODS

Participants

Participants were recruited from community running groups via emails. Sixteen experienced distance (marathon or ultra) runners (n = 11 females, 33.78 ± 9.44 yrs, n = 5 males, 29.4 ± 12.26 yrs) participated in the study. As this was a qualitative study, no power analyses were

conducted, but we based our sample size on previous studies of similar design (24, 26, 39). The average mileage of running per week of participants was 37.38 miles (*SD* = 10.39). The institutional ethics committee approved the study and all informed consent procedures were conducted prior to their participation. Additionally, all the processes of data collection and manuscript writing adhered to the ethical policies set by the Editorial Board of the *International Journal of Exercise and Science* (23).

Protocol

Participants completed the questionnaire via email online or by visiting the motor behavior laboratory. For participants that visited the lab, they were provided a consent form to read prior to completing a paper and pencil questionnaire. For those that chose online, they were provided with the consent form to read and then the questionnaire. The questionnaire was adapted from previous research (8, 25). Specifically, the questions were 1) "*What does your coach or instructor tell you to focus/concentrate on the most when you are practicing your technique?*" Participants were asked to circle one of the four choices: a) How your body, legs and/or arms are moving or should move; b) Important locations/areas in the surrounding environment; c) The implement you are using, d) Equally distributed between the options above. 2) "*When your coach or instructor provides feedback during practice, most of the time you coach gives you advice about?*" Participants were asked to choose one of the four options: a) The end result of your performance (e.g., time); b) Specific information about your performance (e.g., the rotation of your hips); c) Equally distributed between the two options above. 3) "*Describe your focus when you are fatigued.*"

The first question investigates attentional focus cues that participants receive. The second question investigates the type of augmented feedback (i.e., knowledge of performance, knowledge of results, or combination of both. Finally, the third question investigates participants' attentional focus when fatigued. We elected to keep questions 1 and 2 consistent with prior literature (9, 25) to allow for comparisons across studies using different populations (e.g., track and field vs. recreational distance runners). We considered question three preliminary/exploratory to provide a foundation for future research that examines self-adopted attentional strategies during different situations (e.g., fatigued focus versus 'overall' focus). By making this question open ended, it also allowed us to compare our findings to other qualitative findings that did not dichotomize attentional focus (4, 5).

Statistical Analysis

For question 1, response a)—"How your body, legs and/or arms are moving or should move"—was categorized as *internal focus*. Response b)—"Important locations/areas in the surrounding environment" and c) "The implement you are using"—were categorized as *external focus*. Response d)—"Equally distributed between the options above"—was inclusive of internal focus and external focus and categorized accordingly (i.e., 'combination').

For question 2, response a)— "The end result of your performance (e.g., time)"—was categorized as KR, response b)— "Specific information about your performance" was categorized as KP, and c)— "Equally distributed between the options above"—was the combination of a) and b) and categorized as such (i.e., 'combination:' Table 1).

Table 1. Question 1 and 2.

1. What does your coach or instructor tell you to focus /concentrate on the most when you are practicing your technique? (Circle one)
    a) How your body, legs and/or arm are moving or should move.
    b) Important locations/areas in the surrounding environment.
    c) The implement that you are using.
    d) Equally distributed between the options above.
2. When your coach or instructor provides feedback during practice, most of the time your coach gives you advice about: (Circle one)
    a) The results of your performance (e.g., the time it took you to finish)
    b) Specific information about your performance (e.g., the rotation of your hips)
    c) Equally distributed between the options above.

Note. The questions are adapted from *Porter, Wu, and Partridge (2010) and Diekfuss and Raisbeck (2016).*

For question 3 hierarchical categorizations were adopted to capture various aspects of thoughts (27). Specifically, two raters independently categorized the responses into associative and dissociative attention (22). This dichotomous category was further sub-categorized based on previous attentional focus literature that used a deductive method (4). For associative attention, responses were coded as *associative-process* (i.e., task-relevant attention about maintaining rhythm or pace of running), *associative-results* (i.e., task-relevant attention about time, distance, or winning), *associative-psychological* (i.e., task-relevant attention associated with psychological state), *associative-environment* (i.e., task-relevant attention to the results of the movement but on the environment, external focus), *associative-body* (i.e., task-relevant attention the body movements or form, internal focus), *associative-others* (i.e., none of the above categories but task relevant attention). For dissociative attention, responses were coded into *dissociative-psychological* (i.e., task-irrelevant attention associated with psychological state), *dissociative-environment* (i.e., task-irrelevant attention to external to the body), and *dissociative-others* (i.e., neither dissociative-psychological nor dissociative-environment but task-irrelevant) (Figure 1). Two raters independently coded these nine categorizations for question 3. A total of 29 and 32 responses were identified by rater 1 and rater 2, respectively. Proportion of agreement (ratio of both raters answered yes or no to total responses) was 92.67%. Cohen's Kappa (κ) showed 0.77. A group discussion with an additional third rater was used to categorize responses with initial disagreement. Categorizations used for the present results are shown in Table 2.

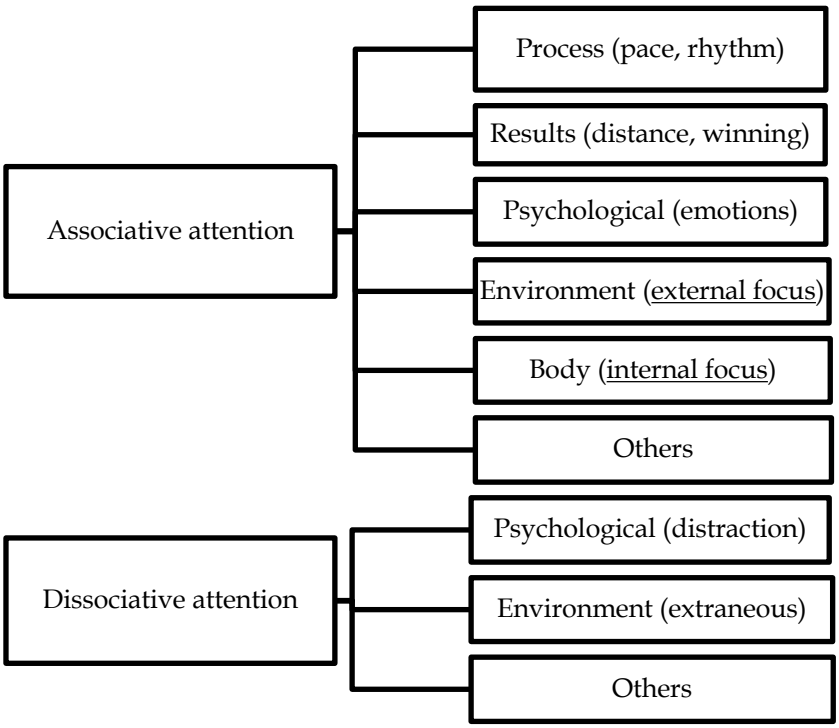

Figure 1. Categories and subcategories of attentional focus that were used to code attentional focus of runners during fatigue.

Table 2. Examples of responses to Question 3.

-When I experience discomfort while running, I try to focus on *maintaining good breathing* A-process, *correct form and focusing on the body parts* A-Body that did hurt. It's a strategy that works best for me.

- I focus on *how much more I have left* A-Results and *how much I am going to hate myself and feel if I stop now* A-Psych. Nothing feels worse than the pain of fatigue than the feeling that you could have gave more.

- I *think about finishing* A-Results in order to get a break, mind over matter, *won't stop* A-Results until done which is my motivation even when I'm in pain.

- When I am fatigued, I *focus on finishing* A-Results and think about '*what my motivation for getting to the finish line is* D-Psych'.

- *Block out the fatigue* D-Others, don't think about it, either clear my mind and *think of nothing* A-Others or *focus on breathing/mechanics* A-Process

- *Try not to walk* A-Results. But if I must, I *find a landmark ahead and force myself to run to that point* A-Env. before walking. "*Find a distraction"* D-Others

- *Counting* D-Others and *breathing* A-Process

- Try to *keep my mind occupied on something else* D-Others

- Think about *beating my best time* A- Results in the next race, *competing with friends* A-Env., *doing well for my school* A-Results

- *Time! Are we done yet? How much farther?* A-Results

- My mantra is, "*Just keep moving forward.*" A-Others

- *Getting to the next arbitrary point (tree or road or mailbox)* A-Env

Note. Coded phrases are italicized; A-Process = Associative-Process, A-Results = Associative-Results, A-Psych = Associative-Psychological, A-Environment = Associative-Environmental, A-Body = Associative-Body Movements, A-Others = Associative-Others, D-Psych = Dissociative-Psychological, D-Environment = Dissociative-Environmental, D-Others = Dissociative-Others.

RESULTS

Attentional Focus Instructions from Coaches: 56.25% (n = 9) answered internal focus, 6.25% (n = 1 surroundings, n = 0 implement) was external focus, 18.75% (n = 2) answered equally distributed, and another 18.75% (n = 2) did not answer the question (Table 3).

Augmented Feedback from Coaches: The results of question 2 showed 4 answered (25%) knowledge of results, 10 answered (62.5%) equally distributed, and 2 answered none of the choices (12.5%). Zero participants chose knowledge of performance (0%) (Table 4).

The results of attentional focus during fatigue are summarized in Figure 2. The results showed 69.97% (20 out of 29 responses) were associative attention and 31.03% (9 out of 29 responses) were dissociative attention. For the subcategories among associative attention, 15.00% (3 out of 20 responses) were associative-process, 50.00% (10 responses) were associative-results, 5.00% (1 response) were associative-psychological, 15.00% were associative-environment, 5.00% were associative-body, and 10.00% (2 responses) were associative-others. Among dissociative attention, 11.11% (1 out of 9 responses) were dissociative-psychological, 22.22% (2 responses) were dissociative-environment, and 66.67% (6 responses) were dissociative-others.

Table 3. Proportion of the type of attentional focus instructions from coaches.

	Internal focus	External focus	Equally distributed (Internal and External focus)
Proportion	56.25%	6.25%	18.75%

Table 4. Proportion of the type of augmented from coaches.

	KR	KP	Equally distributed (KP and KR)	None of the choices
Proportion	25.00%	0%	62.5%	12.5%

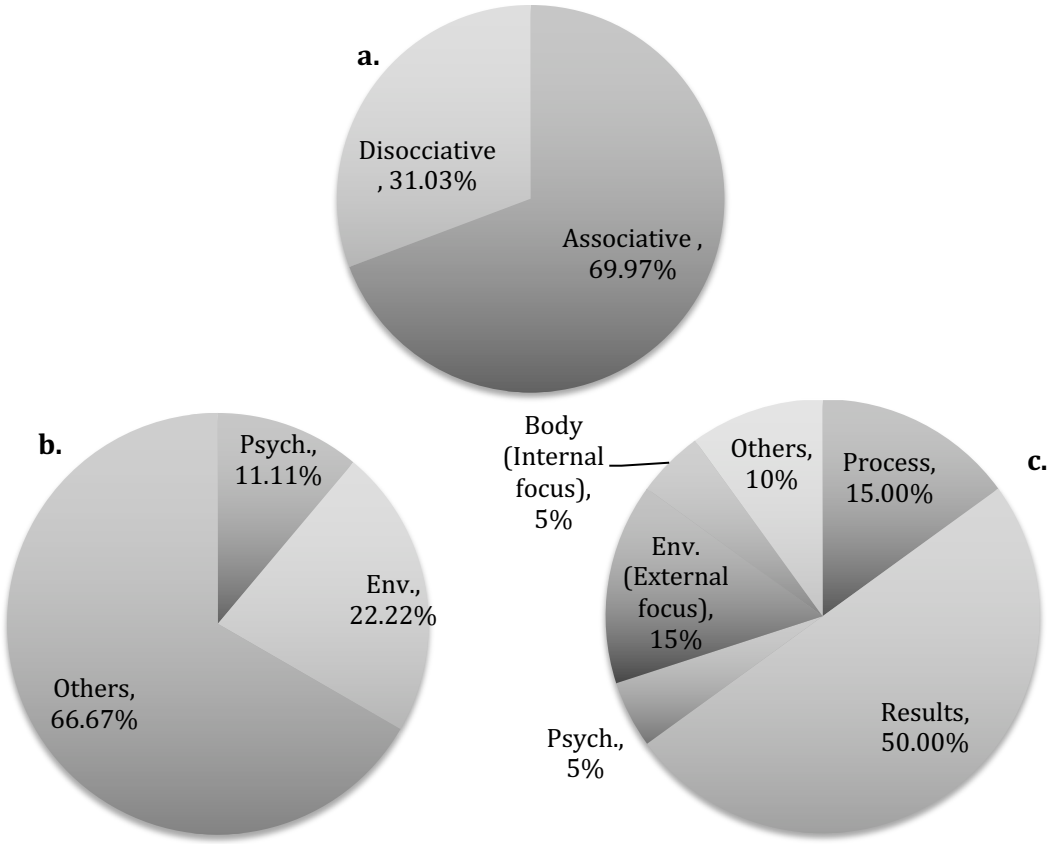

Figure 2. Proportions of attentional focus during fatigue. Psych. = psychological; Env. = environment; a. = Proportion of associative and dissociative attention; b = proportions of subcategories of dissociative attention; c = proportions of subcategories of associative attention.

DISCUSSION

The present study investigated the direction of attentional focus and type of augmented feedback that experienced distance runners receive from their coaches and how it influenced their attention when fatigued. Studies specific to attentional focus have investigated competitive populations such as NCAA Division I (8, 9), elite (4, 5), national level (26), and professional athletes (11). However, a small percentage of athletes continue to compete at collegiate or professional level and the majority engages in running as recreational runners (30). This study extends previous literature (27) by investigating the role of fatigue, attentional focus, and augmented feedback in a population of experienced, recreational, distance runners.

Results from question 1 showed that more than 50% of runners received internal focus instructions and only 6.25% received external focus instruction from their coaches. These results indicated that more education pertaining to the beneficial effects of using an external focus is pertinent, especially given that most of the attentional focus literature supports that using an external focus is more beneficial for performance and learning (10, 16, 19, 44). Qualitative measures in more applied environments show that attentional focus is dynamic, and an external focus is minimally applied, or at least reported (5, 9, 26, 40). The use of instructions may also be

task dependent. For example, men's tennis and women's volleyball (9) and men's baseball (40) are internally focus dominant. Sports such as horseshoes (11) are external focus dominant, and sports such as boxing are more motivational or neutral (13). Understanding that different sports are attracted to different instructional cues, we expected our results for distance running to be similar to track and field (26). Albeit our results reported that 56.25% of distance runners report receiving internal focus cues, Porter et al. (26) demonstrated an even higher percentage (84.6%) in favor of an internal focus. The greater difference may be due to the duration and intensity of the activities (i.e., sprinters and middle distance in Porter et al. (26) and long distance in the present study). More recently, research has shown that that using internally focused instructions was more beneficial for specific changes related to the kinematics of running gait (21). A possible explanation for internal focus showing to be more beneficial for kinematic movement or KP could be related to the time that distance running requires. For example, if we consider the marathon event, this could take some individuals' hours, during which time they may switch between internal and external aspects of the movement depending on how they perceive their body to be responding physiologically and mentally.

The results from question two indicated that participants received equal amounts of KP and KR. This supports previous findings from Diekfuss and Raisbeck (9) suggesting that instructional cues for distance running do not place preference on providing KP or KR. One interesting finding from our study was that none of the participants reported receiving primarily KP, in contrast to the 24.14% reported in collegiate athletes (9) and 38.5% reported in national-level athletes (26). One potential explanation is that the athletes have more experience and are more automatic with their decisions, thus require less or different feedback. Considering both instructions and augmented feedback, one potential connection between the type of instructions and augmented feedback is that these two strategies may influence each other. Porter et al. (26) found the majority of the national level athletes received internal focus instructions and about 40% received KP. The present study showed relatively decreased proportion of internal focus (50%) with decreased proportion of KP (0%) compared to Porter et al. (26). While KP can be provided in either internal or external focus, KR must be relatively goal-oriented information. Therefore, the decreased KP reported in the present study may have influenced the decreased internal focus relative to previous findings.

The third question, that asked participants to write in their attentional focus when fatigued, was purposefully designed as an open-ended format to better understand attentional focus (5, 9, 27). The present study categorized the responses into multiple attentional foci from different paradigms. Specifically, we used Wulf et al.'s (42) definitions of external and internal focus and Morgan and Pollock's (22) definition associative and dissociative attention. This novel categorization may be more effective since associative/dissociative attention categorizations are both task-relevant *and* task-irrelevant, while classic external and internal focus categorizations are directed only to task-relevant cues. Thus, integrating multiple paradigms of attentional focus may provide a better understanding of attentional focus that was largely neglected in the external/internal focus domain (14, 24, 31). Our results from question 3 revealed that approximately 70% of attention was associative and 30% was dissociative. Among the associative attention (a total of 20 responses), only 3 responses were categorized as external or

internal focus, and 50% of the responses in the associative attention were goal-oriented (i.e., associative-results). Fairbrother et al. (11) showed attention to "general success," which is similar to the associative results in the present study, accounted for only 19% and Bernier et al. (4, 5) found that only 4% of participants directed attention to results. The difference in the results from these previous studies may again represent task dependence of attentional foci (9) or differences between the populations (i.e., elite athletes in Fairbrother et al., (11) and experienced recreational runners in the present study). Another explanation for the difference may be that physical fatigue simplified attentional focus, as mental fatigue is associated with physical fatigue (18, 20). It is possible that physical fatigue caused mental fatigue, and thus participants in the present study may not have had the necessary cognitive resources to pay attention to complex thoughts such as techniques (i.e., associative-body or environment).

The present study supported previous literature that the type of instructions and augmented feedback that performers receive from their coaches may be task-dependent (9) and potentially population-specific. Runners' thoughts during fatigue revealed that only small portions of responses were related to either external or internal focus of attention. This finding may provide an important implication since existing laboratory studies adopt a dichotomous category of attentional foci (i.e., associative and dissociative or external and internal foci), which may not represent performers thoughts when performing motor skills. In sum, scientific literature surrounding motor behavior findings have yet to be translated to recreational distance runners. Although primary limitations for this study were the self-reporting retrospective questions and small sample size, we consider the results from this study to be beneficial as it provides a foundation for bridging the gap between laboratory research and real-world application. To overcome such limitations—particularly retrospective feedback—future studies should consider adopting protocols that quantify attentional focus and augmented feedback in real time (i.e., during actual practice or competition). For instance, with the advent of new technologies, runners could provide their current attentional focus in response to a notification on their smartwatch. Success has also been achieved by having researchers provide individuals video feedback of their performance in conjunction with self-conformation interviews to enhance self-recall of adopted attentional focus strategies during different performance phases (1). Similarly, quantification of augmented feedback can be achieved using digital voice recorders or related equipment (13). Future large-scale studies (other populations, additional questions) can further deconstruct if laboratory- suggested recommendations (e.g., an external focus) are actually adopted in the 'real world' to guide translational efforts that most effectively promote strategies to the appropriate populations.

REFERENCES

1. Bahmani M, Bahram A, Diekfuss JA, Arsham S. An expert's mind in action: Assessing attentional focus, workload and performance in a dynamic, naturalistic environment. J Sports Sci 37(20): 2318-2330, 2019.

2. Beilock SL, Carr TH, MacMahon C, Starkes JL. When paying attention becomes counterproductive: Impact of divided versus skill-focused attention on novice and experienced performance of sensorimotor skills. J Exp Psychol. Appl 8(1): 6–16, 2002.

3. Beilock SL, Wierenga SA, Carr TH. Expertise, attention, and memory in sensorimotor skill execution: Impact of novel task constraints on dual-task performance and episodic memory. Q J Exp Psychol A 55(4): 1211–1240, 2002.

4. Bernier M, Codron R, Thienot E, Fournier JF. The attentional focus of expert golfers in training and competition: A naturalistic investigation. J Appl Sports Psychol 23(3): 326–341, 2011.

5. Bernier M, Trottier C, Thienot E, Fournier J. An investigation of attentional foci and their temporal patterns: A naturalistic study in expert figure skaters. Sports Psychol 30(3): 256–266, 2016.

6. Brick N, MacIntyre T, Campbell M. Attentional focus in endurance activity: New paradigms and future directions. Int Rev Sports Exerc Psychol 7(1): 106–134, 2014.

7. Connolly C, Janelle C. Attentional strategies in rowing: Performance, perceived exertion, and gender considerations. J Appl Sports Psychol 15(3): 195–212, 2003.

8. Diekfuss JA, Raisbeck LD. Attentional focus in NCAA Division 1 golfers. J Mot Learn Dev 5(2): 240–251, 2017.

9. Diekfuss JA, Raisbeck LD. Focus of attention and instructional feedback from NCAA Division 1 collegiate coaches. J Mot Learn Dev 4(2): 262–273, 2016.

10. Ducharme SW, Wu WFW, Lim K, Porter JM, Geraldo F. Standing long jump performance with an external focus of attention is improved as a result of a more effective projection angle. J Strength Cond Res 30(1): 276–281, 2016.

11. Fairbrother JT, Post PG, Whalen SJ. Self-reported responses to player profile questions show consistency with the use of complex attentional strategies by expert horseshoe pitchers. Front in Psychol 07: 2016.

12. Guss-West C, Wulf G. Attentional focus in a classical ballet: A survey of professional dancers. J Dance Med Sci 20(1): 23–29, 2016.

13. Halperin I, Chapman DW, Martin DT, Abbiss C, Wulf G. Coaching cues in amateur boxing: An analysis of ringside feedback provided between rounds of competition. Psychol Sports Exerc 25: 44–50, 2016.

14. Hutchinson JC, Tenenbaum G. Attention focus during physical effort: The mediating role of task intensity. Psychol Sports Exerc 8(2): 233–245, 2007.

15. Lind E, Welch AS, Ekkekakis P. Do 'mind over muscle' strategies work? Examining the effects of attentional association and dissociation on exertional, affective and physiological responses to exercise. Sports Med 39(9): 743–764, 2009.

16. Lohse KR, Sherwood DE, Healy AF. How changing the focus of attention affects performance, kinematics, and electromyography in dart throwing. Hum Mov Sci 29(4): 542–555, 2010.

17. Magill RA. Motor Learning and Control: Concepts and application. New York: McGraw-Hill Companies Inc.; 2007.

18. Marcora SM, Staiano W, Manning V. Mental fatigue impairs physical performance in humans. J Appl Physiol, 106(3): 857-864, 2009.

19. McNevin NH, Shea CH, Wulf G. Increasing the distance of an external focus of attention enhances learning. Psychol Res 67: 22–29, 2003.

20. Mehta RK, Agnew MJ. Influence of mental workload on muscle endurance, fatigue, and recovery during intermittent static work. Eur J Appl Physiol 112(8): 2891–2902, 2012.

21. Moore, IS, Phillips, DJ, Ashford, KJ, Mullen, R, Goom, T, Gittoes, MRJ. An interdisciplinary examination of attentional focus strategies used during running gait retraining. Scand J Med Sci Sport 29(10): 1572–1582, 2019.

22. Morgan WP, Pollock ML. Psychologic characterization of the elite distance runner. Ann N Y Acad Sci 301(1): 382–403, 1977.

23. Navalta JW, Stone WJ, Lyons TS. Ethical issue relating to scientific discovery in exercise science. Int J Exer Sci 12(1): 1-8, 2019.

24. Okwumabua TM, Meyers AW, Schleser R, Cooke CJ. Cognitive strategies and running performance: An exploratory study. Cogn Ther Res 7(4): 363–369, 1983.

25. Pennebaker JW, Lightner JM. Competition of Internal and External Information in an Exercise Setting. J Pers Soc Psychol 39(1): 165-174, 1980.

26. Porter J, Wu W, Partridge J. Focus of attention and verbal instructions: Strategies of elite track and field coaches and athletes. Sports Sci Rev 19(3): 199-211, 2010.

27. Raisbeck L, Yamada M, Diekfuss JA. Focus of attention in trained distance runners. Int J Sports Sci Coach 13(6): 1143-1149, 2018.

28. Raisbeck LD, Yamada M, Diekfuss JA, Kuznetsov NA. The effects of attentional focus instructions and task difficulty in a paced fine motor skill. J Mot Behav 52(3): 262-270, 2020.

29. Rotella RJ, Gansneder B, Ojala D, Billing J. Cognitions and coping strategies of elite skiers: An exploratory study of young developing athletes. J Sport Psychol 2(4): 350–354, 1980.

30. RSUA News. U.S road race participation numbers hold steady for 2017, 2017. Retrieved from: https://runningusa.org/RUSA.

31. Russell WD, Weeks DL. Attentional style in ratings of perceived exertion during physical exercise.Percept Mot Skills 78: 779-783, 1994.

32. Salmoni AW, Schmidt RA, Walter CB. Knowledge of results and motor learning: A review and critical reappraisal. Psychol Bull 95(3): 335–386, 1984.Schmidt RA, Young DE, Swinnen S, Shapiro DC. Summary knowledge of results for skill acquisition: Support for the guidance hypothesis. J Exp Psychol 15(2): 352–359, 1989.

33. Schmidt RA, Young DE, Swinnen S, Shapiro DC. Summary knowledge of results for skill acquisition: Support for the guidance hypothesis. J Exp Psychol 15(2): 352–359, 1989.

34. Schomer H. Mental strategies and the perception of effort of marathon runners. Int J Sports Psychol 17: 41–59, 1986.

35. Schücker L, Hagemann N, Strauss B, Völker K. The effect of attentional focus on running economy. J Sports Sci 27(12): 1241–1248, 2009.

36. Schücker L, Jedamski J, Hagemann N, Vater H. Don't think about your movements: Effects of attentional instructions on rowing performance. Int J Sports Sci Coach 10(5): 829–839, 2015.

37. Schücker L, Parrington L. Thinking about your running movement makes you less efficient: Attentional focus effects on running economy and kinematics. J Sports Sci 37(6): 638–646, 2019.

38. Shea CH, Wulf G. Enhancing motor learning through external-focus instructions and feedback. Hum Mov Sci 18(4): 553–571, 1999.

39. Stanley CT, Pargman D, Tenenbaum G. The effect of attentional coping strategies on perceived exertion in a cycling task. J Appl Sport Psychol 19(3): 352–363, 2007.

40. van der Graaff E, Hoozemans M, Pasteuning M, Veeger D, Beek PJ. Focus of attention instructions during baseball pitching training. Int J Sport Sci Coach 13(3): 391–397, 2018.

41. Winkelman NC, Clark KP, Ryan LJ. Experience level influences the effect of attentional focus on sprint performance. Hum Mov Sci 52: 84–95, 2017.

42. Wulf G, Höß M, Prinz W. Instructions for motor learning: Differential effects of internal versus external focus of attention. J Mot Behav 30(2): 169–179, 1998.

43. Wulf G, Mcconnel N, Gärtner M, Schwarz A. Enhancing the learning of sport skills through external-focus feedback. J Mot Behav 34(2): 171–182, 2002.

44. Wulf G, McNevin N, Shea CH. The automaticity of complex motor skill learning as a function of attentional focus. Q J Exp Psychol. A Hum Exp Psychol 54(4): 1143–1154, 2001.

45. Wulf G, Shea C, Park JH. Attention and motor performance: Preferences for and advantages of an external focus. Res Q Exer Sports 72(4): 335–344, 2001.

46. Wulf G, Shea CH. Principles derived from the study of simple skills do not generalize to complex skill learning. Psycho Bull Rev 9(2): 185–211, 2002.

47. Zachry T, Wulf G, Mercer J, Bezodis N. Increased movement accuracy and reduced EMG activity as the result of adopting an external focus of attention. Brain Res Bull 67(4): 304–309, 2005.