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“To Think, or Not to Think, That Is the Question”

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Understanding and explaining the mechanisms, cognitive processes, and self-regulatory strategies that enable the acquisition and proficient execution of motor skills pose significant challenges for the evidence-based practitioner. In this article, we critically consider contemporary theoretical and research findings focused on the scientific study of mental processes in elite performers, specifically in relation to the preparation, practice, and execution of self-paced skills. On examination of some of the current issues in this ongoing debate, we seek clarity as to best practice, and present evidence as to why holistic temporally accurate movement cues hold significant advantages for elite performers.

Keywords: attentional resources, sport psychology, applied practice, rhythmicity

Within the realm of performance sport, appropriate self-directed thought processes before and during task execution have been shown to make a significant difference to the level of performance attained (Abernethy, Maxwell, Jackson, & Masters, 2007; Singer, Lidor, & Cauraugh, 1993). Researchers currently describe differing approaches to the attentional processes underpinning skilled performance. These range from developing conscious thoughts related to performance (e.g., self-talk), to negating the interference certain mal-cognitions can have on skilled performance (Moran, 2009).

The bearing that cognitions and mental strategies have on performance, as well as the ability of the protagonists to suppress conscious activ-

ity as they seek to prepare for and then execute movements, constitutes a remarkably worthwhile area to consider (Singer, 2000). Furthermore, as evidence-based practitioners seek to understand the most effective allocation of thought processes for the sport performers they are working with, specific empirical literature is required to guide and inform professional practice. Therefore, it is in the professional interests of applied sport psychologists that this debate is resolved. Reflecting these stances, the purpose of this article is twofold: to critically consider the current literature on cognitions and attentional foci pertaining to the execution, practice, and preparation for elite performance, and second, to examine some of the current issues in this ongoing debate, seeking clarity to determine guidelines for best practice.

The Role of Automaticity in Performance Execution

Automaticity is associated with the execution of skilled movement. From a performer's perspective, it is considered to be fast, effortless and requires little, or no technical attention on their part (Bargh & Chartrand, 1999). Automatic mental processes free one's limited conscious attentional capacity (Kahneman, 1973) to allow rapid processing, and results in physical actions that appear to require little or no thought

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(Singer et al., 1993). This is opposed to the defining features of conscious processing, which are mental acts that individuals are aware of, that are intentioned, require effort, and are also controllable (Logan & Cowan, 1984). Performance impairment experienced by highly skilled, but anxious, athletes is often owing to the disruption of automatic task control processes (Collins, Jones, Fairweather, Doolan, & Priestley, 2001; Hardy, Mullen, & Jones, 1996; Maxwell, Masters, & Eves, 2000). In this regard, two types of thought processes are identified in the literature as “consciously” interfering with automated movements: performers exerting *conscious control* over, or *monitoring* their execution of movements.

Although there are a number of similarities between these theoretical positions, there are important conceptual distinctions related to the specific mechanisms. Beilock and Carr’s (2001) explicit monitoring hypothesis predicts that attention paid to explicit step-by-step processes disrupts the execution of proceduralized motor skill that normally run outside of conscious awareness. In contrast, Masters’ (1992) theory of reinvestment suggests that it is the controlled processing of motor skill execution that disrupts autonomous performance. Jackson, Ashford, and Norsworthy (2006) have suggested that explicit monitoring may have a general disruptive effect on motor control and that additional disruption might occur when performers attempt to consciously *control*, as well as *monitor*, their movements. The process of conscious control uses the resources of working memory (Baddeley, 2001) because it requires that task-relevant declarative knowledge be recalled from storage in memory and manipulated consciously to control the movements of the task. The proposed mechanism of disruption is therefore the effortful allocation of attention to previously automated processes (Lewis & Linder, 1997). However, the comparative effects of these two types of conscious thought processing on skilled performance have yet to be investigated empirically.

In an attempt to address this unresolved issue, Toner and Moran (2011) designed an experiment using a more ecologically valid task than those used previously. Specifically, expert golfers either attended to or adjusted certain aspects of their technique while kinematic aspects of their performance were measured. The authors

used a “think-aloud” protocol in an attempt to identify precisely what features of putting performance expert golfers attend to, when asked to adopt their normal focus. From the analysis of the statements, themes emerged relating to skill-internal (get my weight right on my feet), skill-external (aim the blade square at the hole), and rhythm/timing rules (smooth back). Specifically, the “think-aloud” protocol demonstrated that four participants reported one task-related thought, while the other 14 participants reported between two and four task-related thoughts of which they were consciously aware while they were addressing the ball and once the putt had been executed. This finding is interesting, particularly when noting Beilock and Carr’s (2001) claims that consciously attending to step-by-step skilled behavior disrupts the execution of proceduralized motor skill that normally run outside of conscious awareness. Another interesting comparison can be made with Masters’ (1992) assertion that manipulating conscious rule-based knowledge in an effort to control movements disrupts the procedural nature of expert performance. Conversely, Ericsson and colleagues (Ericsson, 2002; Ericsson, Krampe, & Tesch-Römer, 1993; Williams & Ericsson, 2005) have argued that a defining characteristic of such performance is the fact that experts appear to be able to monitor and control their “real-time” performance.

Offering a potential clarification, Toner and Moran (2011) found that conscious monitoring (paying attention to a specific aspect of one’s skill) had a more disruptive influence on putting proficiency than conscious control (technically adjusting golfers’ putting strokes), indicating that expert golfers’ putting was most proficient when they focused externally, or on rhythmical properties of their movements (MacPherson, Collins, & Morriss, 2008). Moreover, Toner and Moran (2011) found that conscious control disrupted the overall consistency of the movement. Specifically, motion analysis technology indicated that technical adjustments did slow down and disrupt a number of important kinematic features (namely, back-swing times, forward-swing times, impact timing, and stroke consistency) of golfers’ putting strokes. Notably, however, the disruption to the timing and consistency of the putting stroke had no significant influence on expert

golfers' putting proficiency, the outcome which, in sporting terms, is the most important variable here.

These findings suggest that different forms of conscious thought processing (i.e., monitoring and control) have differential influences on the execution of expert performance. Clearly, therefore, further research to validate the comparative effects of explicit monitoring and conscious control needs to be conducted, especially as some form of conscious thought would seem central to the ongoing refinement of skills that characterizes elite performers (cf. Carson & Collins, 2011). Of equal importance, such research needs to take place in environmentally valid settings since-to date; many of the studies have used contrived, or overly simple tasks (Beilock, Carr, MacMahon, & Starkes, 2002; Gray, 2004; Mullen & Hardy, 2000). Consequently, the derived results offer insufficient implication to guide, or enable considered applied practice.

Of course, some researchers would question the need for any conscious thought at the top level. According to early models of skill acquisition (Fitts & Posner, 1967), athletes pass through three linear stages (cognitive, associative, and autonomous) en route to becoming highly skilled. In the highest stage of skill acquisition, however, it is believed there is no need for thought or conscious control (Vickers & Williams, 2007). Moreover, in recent models of skill acquisition, researchers have identified a state beyond automaticity that athletes must attain before they can consistently achieve the highest levels of expertise (Vickers & Williams, 2007).

In contrast, based on studies of experts across domains, Ericsson and colleagues have asserted that theories relating to the automaticity of human movement are limited explanations of the processing and execution relating to skilled performance. Indeed, Williams and Ericsson (2005) propose that experts maintain high levels of conscious monitoring and control, which are essential for further improvements in performance to be realized. Furthermore, such monitoring processes provide feedback through reportable thoughts (Eccles, 2012) involving planning, reasoning, and anticipation that can be used to diagnose sources of error. It is suggested that derived mental processes of this nature, enable prac-

tioners to design cognitive and behavioral interventions to enhance clients' performance, and enable them to breakthrough current performance plateaus (cf. Ericsson & Kintsch, 1995).

The contention that experts experience heightened (rather than decreased) levels of conscious thought processing during task execution was recently documented by McRobert, Ward, Eccles, and Williams (2011): It was demonstrated that the volume of thoughts (the majority of which were task-related) reported by skilled, versus less skilled, athletes during performance was higher. Therefore, this finding suggests that experts' incidental memory for task-relevant information is superior to that of novices. Moreover, with regard to expert performers, this implies that aspects of perceptual and motor control are mediated by attention-demanding cognitive processes (Ericsson & Lehmann, 1996). However, the distinction may be even more subtle than this. For example, work by Toner and Moran (2011) showed that only certain *types* of thought disrupted performance: a topic which we will return to later in this article.

Notwithstanding whether the direction of conscious thoughts should be task-related or promote automaticity through unconscious processing, these emerging distinctions between different types of cognitions represent the two extremes of the debate. To characterize the ideal mental state in relation to experts' motor execution as a dichotomy between conscious and unconscious thought lacks subtlety. Based on emerging evidence (cf. Toner & Moran, 2011) is the assertion that a motoric process takes cognitive capacity, but it holds no *necessary* implication as to the degree to which the process must be consciously, as opposed to autonomously, guided (Bargh, 1989; Kahneman & Treisman, 1984). This is especially true in tactical decision-making environments, or deciding on shot selection where weighing options and rehearsing scenarios using imagined outcomes is central to the execution of gross motor skills. Therefore, the debate is still ongoing regarding the most appropriate allocation of attentional resources for executing skilled performance.

Can Implicit Practice Methods Be Adopted in the Elite Environment?

Most automatic processes will require an appreciable amount of training to develop fully (Schneider & Shiffrin, 1977). Therefore, how elite performers train and subsequently practice their skills is an important aspect for sport psychologists to consider. Advances in cognitive psychology have demonstrated that the acquisition of motor skill expertise relied on the progression of knowledge, from declarative where performance is consciously controlled, to procedural and then tacit knowledge where task execution is automatic and requires little attention (Bennett, 2000; Masters, 2000). Given the serious consequences of perturbed motor behavior for athletes, it is not surprising that researchers have sought to develop empirically derived techniques influenced by advances in cognitive psychology, and operationalized in motor learning.

Implicit motor learning seeks to inure the performer from cognition-related skill breakdown or, as Masters and Maxwell (2008) term it, reinvestment. Reinvestment is defined as the psychometrically determined tendency toward conscious control (Masters & Maxwell, 2008). It is held that reinvestment can be reduced by minimizing the accumulation of consciously accessible task-relevant knowledge, used to control movements at a conscious level (Kinrade, Jackson, & Ashford, 2010; Lam, Maxwell, & Masters, 2010). In simple terms, the logic is that “if you haven’t got the knowledge, you can’t start thinking about it under pressure.” However, although implicit learning studies *may* have fueled theoretical advances in understanding skill acquisition (cf. Gabbett & Masters, 2011), the majority of this evidence has been generated from studies of novice participants performing closed skilled tasks. As such, any application to high-level and more skilled performers must surely be viewed with caution.

In a novel application to expert performers, Rendell, Farrow, Masters, and Plummer (2011) undertook a 6-week training intervention to apply implicit practice for the purpose of technique adaptation of a closed skilled task. Immediately, this raises an important question as to whether these expert performers in the study agreed to skill refinement and, if so, whether or not the resultant adaptations took place on a

truly unconscious level. Specifically, two expert netball players practiced shooting to an adapted ring while responding to a concurrent secondary task (counting the number of low pitched tones within each song that they were listening to). One of the netball players demonstrated a decline in primary task performance from an initial pretest score of 10 out of 15 shots, to a posttest score of 8 out of 15 shots. The secondary task in this study acted as a distraction, which was designed to prevent players from accessing their explicit knowledge base. Unsurprisingly perhaps, one player’s preperformance routine was not robust enough to withstand these distractions, hence the performance impairment. Reflecting on the methodology used, the authors of this study concluded that the dual-task approach to implicit practice is therefore not the most amenable protocol to use in an applied practice environment (Rendell et al., 2011). From our applied perspective, the case for implicit approaches with more skilled performers seems unproven.

A further point of contention regards the rate of learning in dual-task approaches. Specifically, it is too slow for the constraints imposed by elite-level sport. This proposition is based on previous research, which has highlighted the issue of slow learning using dual-task approaches (Hardy et al., 1996; MacMahon & Masters, 2002; Maxwell et al., 2000; Mullen, Hardy, & Oldham, 2007). Moreover, although secondary tasks are a useful research tool because they demonstrate the limited capacity of working memory (Baddeley, 2001), previous researchers (Jackson et al., 2006) have demonstrated that secondary tasks involving verbal responses throughout a performance are not practical to conduct in actual competitive situations, or during skill training where progression is important. Finally, the ecological validity of this approach (are you practicing in the way you will eventually execute) and the transfer back to the real-world is open to question.

As a further attempt to demonstrate the applicability of implicit learning in an applied sports setting, Gabbett and Masters (2011) provided practical training activities and techniques designed to facilitate the development of implicit skills in rugby league. Aspects of their intervention (e.g., “tackle like Frankenstein”) were based on analogy learning (Liao & Masters, 2001). Analogies can be used to present the

key coaching points of a to-be-learned skill as a simple biomechanical metaphor that can be reproduced by the learner without reference to, or manipulation of large amounts of explicit information. The example from Gabbett and Masters (2011) purportedly illustrates how analogy learning is being adopted and adapted to deal with a concept (i.e., the potential to convey implicit practice effects). However, this article was set as a challenge for practitioners to develop further applied techniques within the sports in which they are working, rather than providing research evidence that these strategies were more effective and, consequently, worthy of adoption in conjunction with elite performers. Researchers therefore need to consider exploring new models of implicit learning that are conducive to the elite practice environment (Rendell et al., 2011).

On a slightly different, but related, point, we would also suggest that implicit learning, approached in this analogy-based fashion, is not original. It seems to hold substantial overlap with coaching techniques already proposed in the literature from very different theoretical paradigms (e.g., “bounce-hit”—Gallwey, 1981; mood words and task-relevant cognitions—Rushall, 1979). Both of these approaches use word-based analogy to tighten an optimized focus, albeit from rather different epistemological stances, and certainly a different perspective than the implicit learning constructs suggested by Masters and colleagues. As such, it would seem reasonable to question whether the underlying mechanisms for analogy are uniquely grounded in the implicit learning approach, or whether other, more parsimonious/effective, explanations and applications are available.

As a direct contrast to analogy learning in elite performers, Ericsson and colleagues believe experts’ cognitions relating to gross motor skill execution are not automated. They suggest that experts are continually and consciously processing information pertinent to performance—especially when they are training, and even more so when they are trying to improve various aspects of their performance (cf. Carson & Collins, 2011). Theoretically, automatic processing is learned, retained in a long-term store, is triggered by appropriate inputs, and then operates independently of the performer’s control (Schneider & Shiffrin, 1977). However, because an automatic process uses a relatively

permanent set of associative connections in long-term memory, an automatic process will be difficult to suppress or alter. In comparison, controlled processes capacity is tightly limited, but the cost of capacity limitations is balanced by the benefits derived from the ease with which such processes may be set up, altered, and applied in novel situations—for which automatic sequences have never been learned (Shiffrin & Schneider, 1977).

This raises a further interesting debate with implicit practice methods: if the athlete does not have access to explicit conscious knowledge of how to move, they will be unable to use such knowledge to control, or alter these skills once technical errors emerge (Beek, 2000; Lam et al., 2010). Moreover, the athlete may face difficulties with new skill challenges that emerge from altered constraints (Carson & Collins, 2011). Therefore, implicit learners may be unable to learn from, correct, and prevent errors in subsequent performances (Baddeley & Wilson, 1994), especially when some transfer of initial learning is required (cf. Barreiros, Figueiredo, & Godinho, 2007; Porter, Landin, Hebert, & Baum, 2007). This lack of explicit information could also leave less material for the performer to rehearse and, consequently, result in spare attentional capacity being erroneously focused on distracting information (Bennett, 2000). We would therefore suggest that implicit motor learning in the high-performance sporting environment offers significant challenges to practitioners faced with how to adapt skills that are well learned.

Preparing to Think, or Not to Think?

The goal for many sport psychology practitioners is to help athletes develop their mental skills, with the aim to facilitate performance consistently at an elite level (Harmison, 2011). Evidenced by the publication of psychological technique use by sport performers and studies of interventions designed by practitioners (Gardner & Moore, 2006), the extant studies have made noteworthy contributions to our current understanding of performers’ psychological preparation for competition (Eccles, 2012). Reviewing this literature, most researchers consider psychological techniques to have a cognitive basis even if they have behavioral components (e.g., goal setting). Furthermore,

Vealey (1994) stated that a major premise of mental skills training (MST) is that athletes may need to learn cognitive skills and strategies to cope with the various demands of sport competition. Thus, given that psychological strategies essentially involve cognitive processes (Eccles, 2012), reports about psychological strategies are essentially reports about cognitive processes.

In this regard, the use of preperformance routines has long been advocated as a tool through which these higher levels of (cognitive) performance and consistency can be achieved (Cotterill, 2010). Both empirical and anecdotal evidence suggest that preperformance routines are effective as a means for promoting physical and mental readiness before performance execution (Lidor & Singer, 2007). Numerous hypotheses have been investigated to explain the functions which preperformance routines fulfill. With regards to thought processes, these include diverting attention from task-irrelevant to task-relevant thoughts (Gould & Udry, 1994), dealing with distractions (Boutcher & Crews, 1987), acting as a trigger for well-learned movement patterns (Lonsdale & Tam, 2008), and prescribing an attentional focus (Harle & Vickers, 2001).

Of course, if these various functions of preperformance routines are to be fulfilled, then associated self-regulatory techniques are essential (Carver & Scheier, 1998). Implementing this approach to psychological preparation therefore requires the allocation of appropriate cognitive-behavioral techniques to allow the athlete to transform maladaptive cognitions to those that are readily adaptable (Andersen, 2005). Cotterill, Sanders, and Collins (2010) and Jackson and Baker (2001) advocated the use of different cognitive techniques within elite athlete's preperformance routines, for example, self-talk, imagery, trigger words, and distraction-avoidance techniques were documented to control and direct performer's emotions, thoughts, and attention, thereby placing emphasis on developing athletes' conscious thoughts that promote better task/performance. As Hardy, Oliver, and Tod (2009) recently stated, rather than focusing on helping athletes deal with thoughts they are trying to avoid, a more proactive strategy may be to assist them in identifying thoughts they want to have at specific moments in time. The focus therefore be-

ing on promoting techniques that can aid the right thoughts tailored to preparation and optimal execution (Cotterill, 2011).

In contrast to these developments, there has been an increasing amount of literature that has sought to determine the cognitive techniques that underlie unconscious processing (Kinrade et al., 2010; Lam et al., 2010; Liao & Masters, 2001). One such construct is the use of priming as a preparation tool for performance. Priming refers to "the influence a stimulus has on subsequent performance of the processing system" (Baddeley, 1997, p. 352). To prime an individual's performance, a commonly used method from cognitive psychology is for participants to be presented with a series of five-word items in which they are required to use four of the words to form a grammatically correct sentence (Bargh, Chen, & Burrows, 1996; Kay & Ross, 2003; Srull & Wyer, 1979). It has been suggested that primes developed to manipulate performers' foci toward global aspects of performance would be advantageous, as they would facilitate automaticity (Bargh et al., 1996; Bruce, Carson, Burton, & Ellis, 2000; Hull, Slone, Meteyer, & Matthews, 2002). Priming has been supported in the literature pertaining to social cognition (Bry, Follenfant, & Meyer, 2008; Dijksterhuis & Van Knippenberg, 1998; Schubert & Häfner, 2003); however, by comparison, sports scientists working with advanced performers have conducted little research on this topic.

In attempts to close this gap, recent innovative applications to physical performance have been undertaken (Ashford & Jackson, 2010; Banting, Dimmock, & Grove, 2011; Bry, Meyer, Oberlé, & Gherson, 2009). Researchers have used a scrambled sentence method, which is undertaken by participants before a hockey-dribbling task (Ashford & Jackson, 2010), a cycling task (Banting et al., 2011), and a relay race (Bry et al., 2009). Arguably, only the first of these three studies was concerned with priming impacts on motor aspects of performance. Both Banting et al. and Bry et al. could be seen to have influenced motor performance through changes, not in priming motor execution, but rather in enhancing motivation—a more traditional use of interventions that use priming (e.g., the relation between the strength of the prime and the strength of the resulting behav-

ioral effect, Dijksterhuis & van Knippenberg, 1998).

In light of the dual purposes of the present article, the aforementioned Ashford and Jackson (2010) study requires further consideration. First, the preperformance priming condition was contrasted with an in-performance explicit focus condition, a technique seemingly designed to obstruct performance by promoting thinking about the task through explicit instructions (Baumeister, 1984). Moreover, the difficulty of a task within the constraints of the experimental protocol operationally delineates its nominal level of difficulty (Guadagnoli & Lee, 2004). This skill-focus condition involved a secondary task and thereby posed an additional cognitive challenge, which is not directly comparable with any of the other conditions used within the Ashford and Jackson study. Second, and attempting to address this erroneous preperformance to in-performance contrast, the new priming approach was not compared with another, more well-established preperformance strategy. Not only would this represent a fairer comparison (between two preperformance strategies), it would also enable an evaluation of the comparative efficacy of priming against another empirically supported preparation technique.

Reflecting these stances, a recent study by Winter and Collins (2013) investigated the comparative efficacy of the primarily conscious technique of imagery (Holmes & Calmels, 2008), to the unconscious priming paradigm (Bargh et al., 1996; Bruce et al., 2000; Hull et al., 2002). Ashford and Jackson's (2010) hockey-dribbling task was adopted for the study. Participants were required to use an Indian dribble to maneuver a field-hockey ball around a 12-m slalom course, marked out by cones at 1-m intervals. The priming intervention took the form of a scrambled sentence task (Srull & Wyer, 1979), words associated with autonomous performance were selected for the content of the prime: for example, "controlled," "fluent," and "graceful." Before completing trials, participants were given unlimited time to complete the grammatical task, comprising 30 five-word items presented in a random order: for example, "slalom balanced was the where." Participants were instructed to use four of the five words presented to form a grammatically cor-

rect sentence, for example, "the slalom was balanced."

Examination of performance times across the four attention conditions revealed performance to be significantly faster in the imagery condition than in all the other three conditions. Furthermore, there was no significant difference in the performance times between the priming and control conditions where participants found priming to have no additional performance benefits than the control instruction of "complete the dribbling task as quickly and accurately as possible." The study therefore provided further support for the efficacy of imagery to elicit enhanced motor performance (Smith, Wright, Allsopp & Westhead, 2007; Wakefield & Smith, 2011). From a philosophical standpoint, Winter and Collins (2013) questioned the examination of techniques in an applied field (sport psychology), which have doubtful application for practitioners working in the real-world with performers.

If practitioners in the field are considering the priming technique as a gross motor preparation tool, additional pragmatic concerns on the application to real-world settings exist. A commonly used method, to prime an individual's performance, is for participants to be presented with a series of five-word items in which they are required to use four of the words to form a grammatically correct sentence (Bargh et al., 1996; Kay & Ross, 2003; Srull & Wyer, 1979). The scrambled sentence paradigm has been used to determine how a cognitive representation primed in one situation affects behavior in a seemingly unrelated scenario (Bargh & Chartrand, 2000). Expecting athletes to complete sentence-scrambling tasks before performing could be viewed as unrealistic. Alternative methods of presenting the primes (e.g., a video containing subliminal primes or flashcards) are therefore necessary (Bruce et al., 2000) if practitioners working in the real-world are to adopt priming as a gross motor cue.

Another issue that bears on the utility of priming relates to the nature of participant awareness of the prime. When participants complete priming tasks in research settings, it is a novel activity (Ashford & Jackson, 2010; Bargh et al., 1996; Hull et al., 2002). The priming paradigms are proposed to be implicit in nature, as participants are not aware of the prime or its intended effect. However, if practitioners in the

sporting world were asking athletes to perform the priming technique on a regular basis—as part of their psychological preparation—this premise would certainly be compromised. Moreover, from an applied standpoint there are important practical considerations to be resolved if priming only works when the performer is unaware as to the purpose of the technique. This is certainly implied by the “mere exposure” construct (Zajonc, 1980), where explicit, as opposed to implicit, priming reduces the effect (Bornstein, 1989). Furthermore, applied practitioners are guided by codes of conducts published by their governing bodies (e.g., the American Psychological Association—APA; British Psychological Society—BPS; and the British Association of Sport and Exercise Sciences—BASES). Therefore, for applied practitioners to use a technique with their performers on a regular basis that essentially, they cannot disclose the purpose of poses an interesting ethical question (Biddle, Bull, & Seheult, 1992; Petitpas, Brewer, Rivera, & Van Raalte, 1994).

Techniques developed to use unconscious processing to facilitate automaticity are a contentious matter. Reflecting these concerns, the debate is ongoing regarding the comparative efficacy of strategies to develop conscious thoughts that are conducive to physical performance.

Offering a Middle Ground for Applied Practitioners

A significant percentage of sport psychology research to date has focused on reducing the effects of “unwanted” cognitions. As discussed previously, theoretical propositions (e.g., the explicit monitoring hypothesis and theory of reinvestment) have considered the effects of debilitating cognitions (Beilock & Carr, 2001; Masters, 1992) and their associated effects on performance in sport. With regards to these, Toner and Moran (2011) found that conscious control is not *necessarily* detrimental to skilled execution, especially if directed to an external focus or on rhythmic properties of movement. Through concentrating on the holistic nature of movement, conscious control is thereby countering the negative aspects of explicit methods, while conveying the positives of implicit practice effects. Evidence from the sport psychology

literature in this regard can be exemplified through the work on the impact of holistic and rhythmic cues.

In the Toner and Moran (2011) study, technically adjusting golfers’ putting strokes disrupted the overall consistency of the movement. This result supports the findings from an earlier case study that examined the mental foci and movement patterns of three international standard javelin throwers and one elite world-class thrower. One of the international standard javelin throwers (MacPherson et al., 2008), focused on arm/shoulder speed—a subset of the whole throw. As a consequence of this verbally administered part-skill cue, the rest of the movement pattern led to relative instability of the whole, or holistic movement pattern. Qualitative analysis of post training and event cognitions elicited by the athlete revealed that the athlete’s attention was focused on a subcomponent rather than the whole movement: “attending to one subroutine may have interfered with the consistency of the whole movement” (p. 299). In short, focus on one part of the skill may provide a consistent execution of an inevitably less than optimum pattern.

Masters (1992) predicts that focusing on part of a movement, using process goals that are underpinned by explicit knowledge, may disrupt the normal automatic task processing of experts. Consequently, this leads to lapses into conscious control and subsequent performance impairment. Researchers therefore suggest that, to prevent performance impairment under pressure, a single holistic movement-focused goal will be more effective than a single part movement-focused goal (Collins, Morriss, & Trower, 1999; MacPherson et al., 2008; MacPherson, Collins, & Obhi, 2009; Mullen & Hardy, 2010). For example, Mullen and Hardy (2010) used three different motor tasks to examine the impact of different mental sets in association with high cognitive state anxiety. A single holistic process goal interacted with increased levels of cognitive state anxiety to help maintain or improve motor performance. In contrast, a single part process goal led to inferior performance, under the same conditions. Specifically, Mullen and Hardy suggest that holistic process goals may allow performers to incorporate the individual subunits of a task into a single global representation, allowing the movement to run more smoothly and automatically. Notably

however, teasing out the role of cognitive anxiety in this interaction may require more detailed, even qualitative, examination.

Evidence pertaining to rhythmicity lends credence to this idea, and advocates focusing on holistic temporally accurate movement cues (Collins et al., 1999); in short, stressing what *is* required rather than trying to counter what might prevent it (cf. Hardy et al., 2009). Part of the explanation as to why rhythm holds considerable benefits for the optimization of movement patterns across sports can be found in recent advances in neuroscience. Where a patient's ability to time and sequence patterned coordination has been lost, the use of external rhythmic cues has been shown to reinitiate ambulatory movement patterns in patients suffering from movement disorders (Praamstra, Stegeman, Cools, & Horstink, 1998). Rhythm used in this way enables direct communication with stored representations of movement, which can, in turn, initiate effective movement patterns. In simple terms, this direct line may help the performer to bypass the potentially disruptive emotionally charged or negative self-talk cognitions, which are justifiably identified as the enemy of expert performance. Illustrating this point, recently, following Phil Mickelson's Open Golf Championship win, his coach, Butch Harmon, stated the following, "*All we spoke about (in preparation for the final round) was the rhythm of his swing and that was phenomenal all day Sunday*" (Murray, 2013).

Empirical research on rhythm and the effect it is deemed to play on successful task execution is increasingly evident. For example, Renshaw and Davids (2006) contrasted the respective run-ups of cricket bowlers and long jumpers. It was determined that cricket bowlers demonstrated lower gait variability than long jumpers and accordingly, this enabled bowlers to develop, "*a stable rhythmic movement pattern at a controlled velocity*" (Renshaw & Davids, 2006, p. 16).

However, the central question—germane to this portion of the present article—is concerned with determining whether or not rhythmic movement patterns are associated with better performances—particularly when athletes, as is often the case, are required to move at close to peak horizontal velocity. In a study conducted by MacPherson, Collins, Graham-Smith, and Turner (2013), six full-time international ath-

letes, all of whom were/are elite horizontal jumpers were filmed on approach to the take-off board in competitions over a 2-year period. In four out of the six athletes, a clear positive association was determined between low levels of footfall variation (i.e., rhythmical footfall) and jumps which were in each athlete's upper quartile of distances achieved. Therefore, it can be asserted that there are increased levels of evidence to associate stable rhythmic movement patterns, not only with specific sports, as in the case of golf and cricket, but of superior personal performances for elite performers.

Recording and replaying the rhythmical (footfall) or heightening a performer's kinaesthetic appreciation of a honed practiced golf-swing acts as a further exemplar link between cognition to movement: more specifically, it demonstrates the effect of using an auditory template as not only a movement cue, but also as a buffer against unwanted or unintentional thoughts. In the case study of the elite javelin thrower (MacPherson et al., 2008), an interesting pattern was discerned. Movement variability was low in training but, crucially, even lower in competition. However, the most instructive findings were gleaned when the mental foci of the athletes were contrasted with their respective performances in-event. The elite thrower, immediately following his performance stated that his focus was on, "*Rhythm . . . just rhythm. I have to hear the music.*" In addition, he stated that, "*I work hard on keeping the whole action together*" (MacPherson et al., 2008, p. 298). The "music" to which the elite athlete was referring was the recorded footfall that he rehearsed before throwing (cf. Ainscoe & Hardy, 1987). This external rhythmical cue is "holistic" because it provides accurate temporal information of a complex sequence of movements that corresponds to a stored representation.

In the "preparing to think, or not to think" section, we discussed the use of preperformance routines for promoting physical and mental readiness before execution. Using an auditory cue may also be in effect a preperformance routine and a means of focusing processing capacity on the task, rather than leaving space for an attentional shift to build. Southard and Miracle (1993) used data from the basketball free throw to indicate that the consistent rhythmicity of preperformance rituals was more important to successful shot outcome than main-

taining the absolute time taken. They concluded that, “we interpret the timing of behaviors to be a natural manifestation of rhythmic activity in the system” (p. 290). A preperformance routine may therefore offer a rhythmical guide that delimits debilitating cognitions and has the effect of maintaining or increasing individual performance effectiveness.

Auditory cues used in training and recalled in competition, offer a number of potential advantages to the athlete. First, the amount of information that can be carried in an auditory rhythm concerning the coordination of a movement pattern is considerable. Second, as we seek to understand the most effective allocation of thought processes for elite performance, rhythmicity encapsulates all three sections of our discussion, namely, execution, practice, and preparation. Furthermore, an auditory rhythm can indicate when the execution of a movement should commence, when it should cease, and how a considerable number of the subroutines involved in the whole movement could be organized in relation to one another (MacPherson et al., 2008). Hence, we are suggesting a change in focus or, at least, an additional focus for applied practitioners: understanding the rhythm and temporal properties of movements can provide meaningful insight into the processes underlying successful motor task performance. This, in turn, may provide the practitioner with important tools for eliciting optimal execution of sport performance, which may offer greater potential than cognitively focused manipulations such as priming or implicit learning.

Conclusion

In any applied discipline, scientist–practitioners seek guidance from a prevailing theoretical and empirical paradigm to underpin, inform, and guide their work. This is an example of translational research, which involves the application of theories, constructs, research findings, and intervention techniques across psychological domains. Through reviewing contemporary theory and research findings focused on the allocation of attentional resources in elite performers, the present discussion has contextualized this process with regards to execution, practice, and preparation, while seeking clarity to optimize practice. As a result, we suggest a

need for further research designed to be impactful in applied settings.

For example, from a cognitive neuroscience approach, future mechanistic explanations could be provided to explain the motor control processes and how these strategies translate to the quality of movement of the limbs, in terms of the neural processes leading to the recruitment of the motor units. Researchers should therefore continue to examine the mechanisms that store, initiate, and retrieve movement, thus furthering our understanding, and enabling appropriate interventions to be attempted. Such an approach would be particularly pertinent to the “performance under pressure” criteria that characterizes sport. Positively, there are already several examples of this approach, using a variety of different tools (MacPherson et al., 2013; Toner & Moran, 2011).

Of course, such an approach places constraints on the design of any study; constraints that may severely limit the experimental “control” that journals may require. The extent to which researchers are able to provide translational research for applied practitioners is dependent on the techniques of interest being ecologically valid: actual task execution must take place in a competitive environment and with all relevant constraints included. It is therefore important for researchers to address the methodological concerns highlighted within this review, and provide ecologically valid testing of the associated theoretical predictions, if further understanding is to be gained and appropriate interventions generated.

Furthermore, the theory–research–practice relations do not have to involve a one-way causal path. Attending to these three reciprocal linkages enables psychologists to ensure that the knowledge, research, and interventions will support one another and advance the field as a scientific and applied discipline. We would recommend it be in our professional interests to seek clarity to determine the guidelines for best practice from experienced practitioners who are currently working in the field. Too often we are coming up with answers to questions which no-one in the applied field has asked, or at least answers to rather selective and limited questions. In addition, elite athletes performing exceptionally well in the sporting world should permit the working model to flow the other way from practice–research–theory. In other words,

all parts of the researcher–practitioner team can benefit.

In summary, a notion has emerged from the literature that certain types of thinking are detrimental to optimal execution, or that performers should avoid thinking when performing. The evidence we presented to counter this advocates a focus on holistic temporally accurate movement cues. Reflecting the discussed parameters, we provide an overview as to why externalized auditory rhythms hold significant advantages in the execution, practice, and preparation for elite performers. Accordingly, allowing practitioners to adopt a strategy that is both applicable to an ecologically valid environment and that encourages individuals to focus on an optimal source of movement information.

Understanding and explaining the mechanisms, cognitive processes, and self-regulatory strategies that enable the acquisition and proficient execution of skills, thus poses challenges for the evidence-based practitioner (Singer, 2000). From the psychological evidence presented, the logical conclusion is clear: actual thinking is not the issue; it is thinking the wrong way that is the problem!

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