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Coaching Sprinting: Expert Coaches' Perception of Race Phases and Technical Constructs

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ABSTRACT

The general aim of this study was explore expert coaches' technical knowledge of sprint running. The first of two principal objectives related to discovering whether expert coaches divided a sprint race into distinct phases and, if so, which and how many phases. The second objective was to examine the good technique characteristics associated with each phase. Participants for the study comprised seven expert track and field sprint coaches. Findings indicated that the respondents broke sprinting down into three technical phases, the start, the pick-up/drive and the maintenance phase. Important constructs were associated with each phase, which both supported and conflicted with the limited literature available. The principal finding of this study, however, relates to the current dearth of knowledge about good sprint-running technique, an area which requires considerable further investigation before definitive lines of good practice can be confidently applied.

Key words: Biomechanics, Qualitative Research, Sprinting, Track and Field Athletics

INTRODUCTION

Research into coaching and coaches' knowledge has increased considerably over the past two decades [1]. This has been carried out from a number of differing perspectives, utilising an assortment of methodologies [e.g. 2, 3]. The work has included both quantitative and qualitative investigations into the pedagogy [4], sociology [5] and psychology [6] of coaching among others. Although useful in generating a rounded understanding and conceptualisation of how coaches learn, an aspect that continues to suffer from relative neglect is that of coaches' actual content knowledge. Nowhere is this more apparent than within the domain of sprint running [7]. Although some recent work has begun to partially address this inattention, the focus to date has been limited to an examination of full speed or maximal velocity sprinting [7]. Alternatively, the limited sprint coaching professional literature gives credence to dividing a sprint race into a number of technical phases each

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comprising several separate, more manageable components [7, 8]. Such work, however, has failed to arrive at more concrete conclusions about coaches' systematic considerations of such phases in terms of the technical constructs vital for each, and how that knowledge relates to researched kinesiological literature.

The general aim of this study was explore elite coaches' technical knowledge of sprint running. Specifically, the first of two principal objectives lay in establishing whether the practice of dividing a sprint race into distinct phases is employed by expert coaches, and, if so, into which, and how many, phases. The second objective was to explore the good technique characteristics associated with each phase. The significance of the work is grounded in the need not only to better understand the principal constructs that underpin sprinting, but to specify which ones matter most at different race phases. In addition to identifying such technical knowledge, the value of the work lies in deepening our understanding of coaches' existing knowledge and daily practices, allowing for the rationalisation of existing information while uncovering and exploring additional possibilities [4, 7]. This is particularly so in relation to comparing coaches' technical knowledge of sprinting to that generated from empirical, largely biomechanical, research [e.g. 10-12]. Finally, the merit of the work also lies in further developing the coaching-biomechanics interface [3], whereby coaches' knowledge is converted into biomechanical variables that can be analysed theoretically. Such a process is vital considering the substantial governmental sums recently invested into UK 'evidenced based' coaching programmes [13], as the impetus towards the London 2012 Olympic Games gathers speed [7, 14].

METHODS

PARTICIPANTS

Participants for the study included seven expert male track and field sprint coaches. In line with British Association of Sport and Exercise Sciences' (BASES) regulations, each coach gave written informed consent to participate in the study. Similarly, ethical approval for the project was gained from the University's research ethics committee. In line with previous work [7], the coaches were classified as expert based on three criteria: experience, qualification and achievement. First, a minimum of ten years sprint coaching experience was deemed necessary. Second, each coach was required to hold a Level 4 UK Athletics coaching certificate, the highest national award available, or a national sprint coaching position (either currently or previously). Finally, each needed to have coached at least two international performers. Such criteria echo definitions of expert coaches [15-17] in relation to the time spent coaching, the achievement of a performance outcome measure (having coached athletes to, and at, international competitions) and national recognition (in terms of qualifications and positions held). The participants then, were selected through a purposive sampling technique which involved selecting the most productive respondents to address the research aim [18].

DATA COLLECTION

Semi-structured, in-depth interviews were used to explore the coaches' knowledge in terms of the stated aims of the study: that is, if they divided a sprint race into technical phases for the purposes of coaching, and what they considered to be the vital technical characteristics for each different race phase. Such a research method was deemed appropriate as it contains the flexibility to probe and explore at a multitude of levels the discourse used by respondents, allowing a focus not only on the words spoken but also on the meanings intended [18, 19]. In order to adhere to the given aims of the research, an interview guide was developed and

utilised which was, in turn, divided into three sub-sections. Section one focussed on obtaining background information. Section two investigated if and how the coaches divided up a sprint race for analytical and teaching purposes, while section three identified the characteristics the coaches associated with good technique during these phases. All the interviews were digitally audio recorded and transcribed verbatim. Each coach was interviewed once, with each interview lasting on average approximately 70 minutes. The interviews took place at a location of the coaches' choosing. To enhance the credibility and the general robustness of the research process, in terms of identifying and addressing both content related and practical issues, a pilot interview was carried out. Additionally, following completion of the subsequent final interviews with the coaches, the collected data were subject to peer debriefing. Here, discussions with an experienced qualitative researcher centred on the interviewer's consideration of methodological activities as well as the accuracy and completeness of the data collected [20]. Finally, the transcribed interviews were offered to the coaches to check for accuracy and completeness of interpretation.

DATA ANALYSIS

A variant of the grounded theory approach using a constant comparative method was used to analyse the data [21]. To assist in this process, the interviews were examined using ATLAS.ti 5.2 qualitative software, which allowed for the comparison and reassembling of meaningful pieces of textual data in flexible yet systematic ways [7]. The analysis process contained a first stage where initial themes were identified for further exploration. This involved dividing the text, on the basis of frequency and emphasis, into 'meaning units' or portions of data containing a notion related to the topic in question [22]. The contents of these units or constructs were then subject to a search for commonalities and uniqueness. This analytical process resulted in a series of race phases and important technical constructs deemed vital for good quality sprinting within each phase being established, based on the criteria of having been most cited and discussed by the coaches. A particular construct was classified as being high order when it was cited and discussed by four or more of the respondents. Similarly, a construct was classified as being of secondary order when three of the respondents discussed it. As in previous work, through such a continual evaluative progressive process, confidence in the constructs' validity was established [7, 21].

RESULTS AND DISCUSSION

The results are presented in two sections. Section one explores if and how the coaches interviewed divided the sprint race up for purposes of analysis and coaching. Section two meanwhile examines the various constructs, both high and secondary order, identified by the coaches as crucial to optimal sprint running, both in terms of their precise meaning and their deemed importance for each phase. These findings are simultaneously located and analysed in terms of the existing body of knowledge.

THE VARIOUS PHASES OF A SPRINT RACE

Echoing the findings of earlier work [e.g. 9], all seven coaches interviewed believed in breaking a sprint race down into a number of technical phases in order to coach the activity effectively. This was justified in terms of giving the necessary level of specificity in the instruction and feedback: '*because an athlete is much more comfortable with a specific emphasis in the training programme'*. Although the practice of technically dividing a race up was commonly used, no immediate consensus among the coaches as to the exact number of phases that comprise a sprint race was forthcoming. Despite this lack of congruence, all

seven coaches were in agreement that a race should broadly comprise of a start, a middle and an end phase. In probing for greater clarification as to exactly what these phases entailed, clearer definitions emerged. These related to a start phase, a drive/pick-up phase and a maintenance phase. The start phase was seen as ranging from when the athlete obtained a set position in the blocks to the point when the front foot broke contact with the block. The drive/pick-up phase was defined as being from when the athlete's front foot left the block to the point when he or she attained an upright sprinting position. This comprised the initial low drive from the blocks, merging into the gradual attainment of an upright sprinting position. The final maintenance phase was defined as the remainder of the race; that is, from once the athlete had reached an upright sprinting position to when the finishing line was crossed. Such findings are in broad agreement with Collier [9] who labelled three general race phases; acceleration, transition and full speed. Mero et al [23], in a biomechanical review of sprinting, and Dick [24], however, argued for four race phases (start, acceleration, maximum speed and deceleration/maintenance), while Segrave [8] outlined six technical phases, the start, pure acceleration, transition, maximal velocity, speed maintenance and finish. In contrast to Segrave's six phases [8], many of the coaches interviewed in this study warned against over-problematising the sprint race for athletes ('*How complicated are you going to make it? You can make it as complicated as you want'*). Hence, they considered three principal phases an appropriate structure to coach sprinting and the nuances within it. Each phase will now be examined in turn.

THE START PHASE

All of the coaches identified the start phase as being technically crucial to the outcome of a sprint race. In fact, four out of the seven believed it to be the most important phase of all. In the words of one coach, '*the start's so important that the race can be over and done with in two strides*'. A number of differing constructs emerged which they associated with good start technique. In this respect, high-order constructs included 'arm action' and 'body position in the blocks', while the secondary constructs consisted of 'posture', 'thrust position' and 'first step out of the blocks.'

When discussing the precise desired action of the arms during the start phase, there was agreement among the coaches that the arms should be dynamically split, with the contralateral arm to that of the front leg in the blocks extending forward, as the opposite arm flexes backwards. However, disagreement emerged between the coaches as to the amount of elbow flexion that should occur during this dynamic separation of the arms. One coach argued, '*I like to see the leading arm punching far out*' echoing the belief of others for close to maximal elbow extension in relation to the leading arm: '*the arms can be longer, effectively looking like paddles*'. Such maximum elbow extension was justified as helping the front leg in the blocks to reach maximal extension as the sprinter leaves the blocks. Alternatively, another coach stated that the arm action here should be '*short and fast, at 90 degrees*'. Although research into the mechanics of the sprint start has been published [e.g. 11, 25-28], a dearth of work exists relating to the role of the arms during the block start. Nevertheless, one study concluded that the need exists for one arm to extend forwards during the start of sprinting while the other flexes back [29]; findings which echo the belief held by some of the interviewed coaches. Bhowmick and Bhattacharyya [29] also concluded that the arms may aid the control of leg movements, by counterbalancing the angular momentum created by hip rotation. Again, this supports the views of some of the coaches interviewed in the present study in relation to the role of maximal elbow and shoulder flexion during the start phase. However, these results remain speculative as more research into the role of the

arms during the start phase is needed before they can be verified.

The next construct to be identified by the coaches as vital for the start phase of the race was 'body position in the blocks'. 'Body position' was a term widely used by the coaches, although some ambiguity existed as to its exact meaning. It eventually became clear that 'body position' encompassed a number of sub-notions including that of maintaining a straight back. In the words of two of the coaches:

> *I like a straight line from the head right down the back, I like a hip position that's higher than the head, I don't like athletes dropping their head, I think it causes round shoulders.*
>
> *I'm looking at body angles, and I'm looking at a flat back in the set position, because I want the body to go forward and not up. I'm looking at head position which is naturally aligned with the spine and not dropped, because the head's very heavy.*

It was clear from all seven coaches' responses that three underlying sub-notions were important here. These included the position of the shoulders in relation to the start line, the position of the hips in relation to the shoulders, and the head position. When asked to expand upon each of these, a clearer understanding of what the coaches were technically trying to achieve emerged. One coach emphasised the position of the shoulders in relation to the start line in the 'set' position, highlighting the need for the athletes' shoulders to be positioned over their hands, breaking the plane of the start line. Such a belief lends support to the findings of Baumann [30] who concluded that sub-elite (100 m P.B = 11.85 s) sprinters displayed a centre of mass placement further back from the start line than elite sprinters (100 m P.B = 10.35 s). Baumann [30] concluded that a greater percentage of an elite sprinter's body weight was, therefore, placed on their hands during the set position. The researched findings here are by no means unequivocal however, as Mero et al. [25] in a later investigation found that sprinters of any ability should not place more than fifty percent of their total body weight on their hands when in the set position.

Closely linked to this first sub-notion was the position of the hips in relation to the shoulders in the set position. Four of the coaches interviewed identified the need for athletes to achieve a position where the hips are higher than the shoulders in the set position. When discussing this notion the coaches were drawing attention to athletes' vertical centre of mass position. However, Mero et al. [25] identified no significant differences in vertical centre of mass location in the set position between athletes of varying sprint running abilities. The biomechanical literature [e.g., 25] then, has argued that vertical and horizontal centre of mass location in the set position may not play a significant role in sprint start performances. Clearly, further investigation is needed here before definitive lines of good practice can be drawn.

The final sub-notion to be discussed under the term 'body position' by the coaches was 'head position'. Five of the coaches identified head position as being technically important during the start phase. This related to the head being naturally aligned, with no flexion, extension or lateral movement occurring in the neck. The coaches argued that incorrect 'head position' may cause the athletes' shoulders to roll inwards, impacting upon block exit phase mechanics. Although defined as important by the coaches, no empirical work to substantiate or refute their beliefs could be found.

Alongside the two discussed high-order constructs (i.e., 'arm action' and 'body position'),

three secondary constructs were identified as being technically important to the successful completion of the start phase. These included 'thrust position', 'the first step out of the blocks' and 'posture'. Three out of the seven coaches highlighted the technical importance of an athlete achieving the 'thrust position' or 'line of power' just prior to his or her front foot leaving the starting blocks. This related to the ankle, knee and hip joints of the front leg and the back being fully extended creating a straight line between the toe and the top of the head as the sprinter leaves the blocks. As one of the coaches explained:

> *You need to keep the body straight, keep the head in line with the body, and then when you straighten the (front) leg, straighten it so that you eventually end up with a straight position, and the forces are going straight.*

Closely linked to 'thrust position' was the technical ability of the athlete to achieve a correct and mechanically efficient 'first step out of the blocks'. One of the coaches identified the link between these two constructs, stating:

> *If you ask somebody to truly extend fully and only think of that, what you're going to finish up with is a very big first stride, which is not going to be effective once that back leg out of the blocks hits the ground.*

What the coaches believed to be important here was that the first step from the blocks should not be too long in order to minimise the braking forces created on touchdown, thus allowing for maximal acceleration. Coh and Tomazin [31] identified the distance between the start line and athletes' first foot contact as being crucial to the successful execution of the drive/pick-up phase, specifically in terms of minimising braking forces during the first step through not over stepping. Similarly, Frye [32] stated that the free leg should drive forward to place the foot under the body or potentially behind the body depending on how quickly the athlete accelerates.

The final secondary construct to be identified by the coaches was 'posture'. One coach argued that 'posture' was the underlying foundation which allows athletes to attain correct body positions during the start phase. In his own words;

> *During the start, once you bend the back it's going up and you don't want that, so it comes back to posture again; you need fantastic posture to produce good starts.*

Although the term 'posture' was commonly used by the coaches, there was no initial clear-cut understanding as to what it actually meant in the context under study. In probing for greater clarification, it was found that 'posture' referred to the athlete's ability to control the muscles within the trunk, thus maintaining a fairly rigid position during the start phase. As with prior constructs, a number of related notions were intertwined with the term 'posture'. These included 'core stability' and 'core strength'. Two of the coaches identified that technique during the start phase can break down due to the athlete having poor core strength and stability which referred to having ample strength in the trunk muscles; a definition which echoes that given by Kibler et al. [33]. It was apparent, however, that the coaches used the terms 'posture', 'core stability' and 'core strength' interchangeably to describe the same or very similar notions. Unpicking the concept of posture then, proved quite problematic highlighting the need for greater investigation into exactly what was referred to when it was used and how it impacts upon sprint starting performance.

THE DRIVE/ PICK-UP PHASE

Two high-order constructs were identified in the drive/pick-up phase; 'arm action' and 'leg extension'. Although 'arm action' was identified by five of the coaches as being technically important, somewhat echoing the earlier discussion of the construct within the start phase, it proved to be a contentious issue with two differing schools of thought in relation to it emerging. Disagreement was initially evidenced surrounding the amount of elbow and shoulder flexion and extension that should occur during the drive/pick-up phase. Two coaches argued that the elbows should be maintained at a 90 degree angle during the drive/pick-up phase and shoulder flexion/extension should occur rapidly over a relatively small range of motion. For example:

> *I like arms punching back and forward as much in front as behind… I put a lot of credence on just that one part of the physique. Fast arms, 90 degree arms, don't unlock them. I think for the explosive aggression part of sprinting, there's probably no other better part of the body to get them to focus on.*

Countering this view, one coach alternatively described the arms during the drive/pick-up phase as needing to be 'paddle' like ('*longer arms, like paddles'*). Furthermore, two of the coaches' proposed that shoulder flexion/extension should occur over a relatively large range of motion and that the elbow angle should not be fixed. Here then, many questions remain. Similarly, although Thomson et al. [7] identified how previous research [10, 34, 35] has documented the arms' balancing function in relation to the motion of the legs while sprinting, no work seems to have specifically analysed the action of the arms within the drive/pick-up phase.

The second high-order construct to be highlighted by the coaches during the drive/pick-up phase was 'leg extension'. Leg extension referred to the hip and knee joints being fully extended prior to the athlete taking-off from each step in order to maximise the force exerted onto the running track. The coaches also highlighted the need for both legs to be the same, symmetrical but alternate. One of the coaches argued the reason for this maximal extension is '*because you actually want the foot in contact with the ground for as long as possible so the longer the stride pushing back through, the better'*. Although some empirical work exists on the drive/pick-up or acceleration phase (as it is sometimes referred to in the literature) [e.g. 9, 36], specifically in terms of exploring the change in leg mechanics during it, much scope for further investigation exists. This is particularly in relation to examining the impact of maximal leg extension and force generation during the initial ground contacts after exiting the blocks.

Two secondary constructs in relation to the drive/pick up phase were also identified: 'ground contact' and 'posture'. In seeking greater clarification as to 'ground contact's' exact meaning, three of the coaches agreed that it referred to the time from the instant the foot makes contact with the ground to the instant the same foot is lifted from the ground. Here, it was considered, as with the 'first step out of the blocks', that the foot should not strike the track anterior to the body's centre of mass (which causes detrimental braking forces) but should occur underneath the body. As previously stated, Coh and Tomazin [31] identified the position of the foot contact as being crucial to the successful execution of the drive/pick-up phase, specifically minimizing braking forces during the first step. Previous research found that in a group of elite sprinters (n = 25) the centre of mass was only ahead of the point of contact for the first two steps from the blocks [25]. Here, the centre of mass was ahead of contact by 0.131 ± 0.057 m and 0.037 ± 0.047 m in the first two steps respectively, and

behind the contact point by 0.054 ± 0.044 m in the third step. The magnitudes of the standard deviations of these measures, however, suggest that in some subjects it was not always only the first two steps in which the centre of mass was anterior to the contact point in a sprint.

Ground contact time was also emphasised by the coaches as being technically important. One of the coaches highlighted how contact time during the drive/pick-up phase will be longer than later in the race, underlining the importance of force application; "*in the first half-a-dozen steps you've got loads of time and the application of power is actually quite slow"*. This descending trend in contact times sits favourably with the current pool of research. For example, Coh and Tomazin [31] noted that contact phases become shorter and flight phases longer as the athlete progresses from the starting blocks.

The last secondary construct to be highlighted by three of the coaches for the drive/pick-up phase was 'posture'. Although 'posture' was discussed by the coaches during the start phase, it became apparent that they were referring to 'posture' in a slightly different way here. Due to the development of running velocity and the subsequent dynamic changes in running technique, the coaches were referring to the athletes' ability to maintain their dynamic posture only in this respect, as opposed to their static posture. As one coach highlighted:

> *In the acceleration phase, you're looking for an adjustment in posture of developing into the full speed phase as quickly as you can.*

Emphasising its importance, another coach argued that the drive/pick-up phase can break down if the athlete cannot maintain their posture and specifically a rigid trunk position;

> *It's a structure that everything rotates off, and if that structure isn't strong enough then the whole phase will fall apart.*

THE MAINTENANCE PHASE

Two high-order constructs were identified for the maintenance phase; 'hip position' and, again, 'posture'. As with a number of previously discussed constructs, hip position seemed to be a term that encompassed a number of sub-notions that were interchangeably used by the coaches. These included 'tall shape' and 'high hip position'. Hip position referred to the athlete maintaining a relatively high centre of mass, with a slight anterior tilt of the pelvis during the maintenance phase of the race. All seven of the coaches placed great credence on athletes achieving a correct hip position. In this context, one coach stated:

> *I'm looking for that mythical holy grail that all coaches talk about called 'high hips'.*

When asked to describe how hip position impacts upon sprint running technique, two points were forthcoming. The first was that the spatial role hip position plays in the sprinting process, in that if a high or tall hip position is not maintained, body parts cannot attain specific relative positions. The second related to how a high hip position impacts upon the efficiency of the lower leg muscles. This was described in terms of how a low hip position restricts the range of motion over which the lower leg muscles can apply force. The notion of hip position, while being identified as significant by the coaches, has received little coverage within the human movement literature generally (see [7] for a more informative discussion here). Nevertheless, research by Thomson et al. [7] has identified a slowly

emerging trend within sprint coaching literature in relation to granting high hips a position of increased importance [e.g. 9, 37]. The second high-order construct to be identified was 'posture'. The ensuing discussion surrounding posture closely mirrored those surrounding the start and drive/pick-up phases with credence given to having strong core stability [7].

Two secondary constructs were identified as technically important during the maintenance phase; these were 'arm action' and 'relaxation'. When asked to highlight the specific technique of optimal arm action during the maintenance phase, the coaches responses' centred on the following key aspects; 'open arms', '90 degree arms', 'synchronised arms' and 'big range'. When asked to clarify the term 'open arms', the consensus was that the arms should be swung exclusively in the sagittal plane, not across the body. The elbow angle should be maintained close to 90 degrees of flexion, while the movements of both arms should be the same, although opposite in direction; they should be corresponding and complementary. These findings are mirrored within sprint coaching literature generally [31, 38, 39]. All the coaches also believed the technical role of the arms was somewhat different during the maintenance phase in comparison to the preceding drive/pick-up phase. Two specific roles for the arms were identified by the coaches during the maintenance phase. The first was the 'balancing factor' of the arms. One coach believed that the arms help to stabilise the trunk, thus working in tandem with correct posture to create a stable base, aiding leg mechanics. This balancing role has been investigated by sports biomechanists with conflicting findings [10, 34, 35]. For example, Mann [10] and Mann and Herman [34] have argued that the arms are of little importance in the sprinting process, other than in helping the sprinter to maintain balance. Research by Hinrichs et al. [35], however, although carried out on middle distance runners, claimed that the arms play a far more significant role by providing lift and promoting a more constant horizontal velocity for the runner, a view mirrored by the current study.

The final secondary order construct to be highlighted by the coaches during the maintenance phase of a sprint race was 'relaxation'. One coach drew attention to the importance of relaxation, stating that: "*the first thing is relaxation, once they're in the highest position, they must relax"*. This was reiterated by another coach when he stated: "*Relaxation is a biggie, because you've got to produce power with total relaxation, because once you get tension in your body, it goes wrong"*.

Although three out of the seven coaches highlighted the technical significance of 'relaxation', no initial clear-cut explanation of the construct's meaning was forthcoming. Upon further questioning, it became apparent that the coaches were looking for a number of physical indicators, such as maintaining a smooth running action without overly tensing the postural muscles or those of the upper torso, neck and jaw, which causes the shoulder girdle to be raised. The term 'relaxation' does appear in the sprint literature; for example, Carr [39], when referring to sprint technique essentials, highlighted the need for the athletes' hands and facial muscles to be relaxed. Frye [32] agreed, stating that when an athlete is running at full speed they must have relaxed shoulders, neck, jaw and face. Although it is apparent that relaxation is considered an important technical construct for good maintenance phase sprinting, no scientific-based research exists analyzing its actual effect on performance. Again then, greater investigation is required to verify or solidify these claims.

CONCLUSION

The expert sprint coaches in this investigation unanimously broke down a sprint race into technical phases. The coaches justified this practice as facilitating skill learning by giving athletes a specific emphasis in the training programme. The technical phases were the start

phase, the drive/pick-up phase and maintenance phase. Collier [9] and Dick [24] concurred that a sprint race can be divided into three phases, although Seagrave [8] outlined six technical phases. Even though some disagreement is consequently apparent as to the exact number and make up of race technical phases, the practice of coaching particular units before re-introducing them into a greater whole appears commonplace.

Two high-order constructs were identified for the start phase. These were 'arm action' and 'body position in the blocks', while three secondary constructs were established; 'posture', 'thrust position' and 'first step out of the blocks'. During the drive/pick-up phase, 'arm action' and 'leg extension' were identified as high-order constructs, while 'posture' and 'ground contact' were highlighted as secondary constructs. During the final maintenance, phase 'hip position' and 'posture' were identified as high-order constructs, while 'arm action' and 'relaxation' were found to be secondary ones. These findings both endorse and oppose the limited existing literature on sprint running. For example, posture was highlighted in all three technical phases as being an important construct, which echoes work by Collier [9] and Hrysomallis and Goodman [40]. However, no clear agreement was forthcoming in relation to a coaches' definition of posture itself. Similarly, although tentative steps have been taken to examine the function of posture in sports activities, a dearth of research exists referring to optimal posture characteristics, especially regarding how optimal posture may change and impact performance during different technical phases of a sprint race. Additionally, although acknowledged as important, 'head position', 'thrust position' and 'first step out of the blocks' during the start phase, 'leg extension' during the drive/pick-up phase and 'hip position' and 'relaxation' in the maintenance phase have been scarcely investigated within sprint coaching and biomechanics literature. In contrast, 'ground contact' offered the greatest similarity between the coaches' responses and researched findings; that is, the coaches' ideas tended to support existing work.

The most contentious construct was 'arm action', specifically the role and movement pattern of the arms during the different technical phases of a sprint race. Two coaches argued that the arms should be maintained at a 90 degree angle during the drive/pick-up phase and that shoulder flexion/extension should occur rapidly over a relatively small range of motion. Alternatively, a further two coaches argued that shoulder flexion/extension should occur over a relatively large range of motion and that the elbow angle should not be fixed. No agreement here, therefore, was forthcoming. Nevertheless, all the coaches agreed that the technical role of the arms shifted from phase to phase; for example, in the later maintenance phase they increasingly emphasised the arms' balancing function to the motion of the legs, a notion which has been supported by existing literature [10, 34, 35].

The principal finding of this study, however, has been to highlight the general dearth of knowledge underpinning the technical phases of a sprint race and, more importantly, the technical constructs which govern the successful completion of each phase. Similarly, a gap still appears to exist between expert sprint coaches' knowledge and reported researched findings [7]. Hence, many questions remain unanswered detailing the specific impact a multitude of variables have on sprint running performance.

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