The Contribution of Expert Coaches' Experiential Knowledge in Understanding Punching Performance in Boxers

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Abstract

Traditionally, the field of sports science has been interested in conducting research that is predominately quantitative in nature. Although this approach has provided significant findings, this has led to expert coaches' experiential knowledge being neglected in favour of empirical knowledge. By investigating punching in boxing, we are interested in developing an understanding of whether elite coaches, through their experiential knowledge, intuitively identify key characteristics of effective punching as identified in controlled experimental research. For this purpose, five interviews were conducted with professional and amateur boxing coaches. From this qualitative approach it was evident that coaches' knowledge was consistent with that of the empirical research on effective punching performance with four principal components emerging from the interview data. These included: 1) whole body movement, 2) footwork, 3) hip and shoulder rotation, and 4) hand and arm position. The data illuminated how coaches' knowledge can be used to strengthen empirical findings in sports performance, in this case punching in boxing. Additionally, characteristics of performance that were discussed by coaches that were not identified in the empirical literature highlight directions for further research regarding effective punching technique, an area that requires further investigation before conclusive structures of good practice can be applied.

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Introduction

The punch is a fundamental human action that has shaped our collective evolution (Carrier, 2011). From the shape of our faces (Carrier and Morgan, 2014), to the development of our opposable thumbs (Morgan and Carrier, 2013), the closed fist used to strike an adversary can be seen as one of the many defining actions of humanity. As established by van Bottenburg and Heilbron (2006), the punch and similar violent actions have been shaped by 'sportification' as the culture of the world has shifted in modern times. This transformation of human combat into combat sports, through sportification, has provided a platform to better understand the fundamental action of punching through the lens of the performance-driven sport sciences (Burwitz, Moore, & Wilkinson, 1994).

Current understanding of punching performance comes largely from theoretical knowledge attained from laboratory-based investigations exploring kinetics (Atha, Yeadon, Sandover, & Parsons, 1985; Walilko, Viano, & Bir, 2005; Walker, 1975), and kinematics (Girodet, Vaslin, Dabonneville, Lacouture, 2005; VencesBrito, Ferreira, Cortes, Fernandes, & Pezarat-Correia, 2011) at a fundamental level. These studies have described impacts, electromyographic findings, 3D kinematics, and centre of pressure movement during punching. Investigations of coaches' experiential knowledge of performance is scarce (Reider, 2004; Spencer, 2009), with even fewer studies exploring the knowledge of expert coaches to develop a holistic understanding of punching (Halperin, Chapman, Martin, Lewthwaite, & Wulf, 2016).

The lack of research investigating the experiential knowledge of coaches could be explained by the perceived lack of scientific rigour in this type of research. In pursuit of scientific rigour, empirical researchers conduct studies in an artificial or laboratory-based setting (Greenwood, Davids, & Renshaw, 2012). Although research conducted in a tightly controlled setting allows for the control of the factors that may obscure the origin of results, this approach assumes that movements occur in a vacuum. This does raise questions about the representativeness of this approach to a range of contexts (e.g. kinematic punching data in boxing in a laboratory without an opponent versus in a competition against a live opponent). Davids, Button, and Bennett (2008) explains that movements are most often performed in a dynamic context, where the performer is interacting with the environment and adapting movement patterns based on contextual information that is being attained during performance. With the performance environment being dynamic, it is important for practitioners to consider examining kinematics of various movements in realistic environments. Newell (1986) explains that during execution of motor skills, movement patterns are subject to three constraints: environmental, task, and organismic (the individual). All three of these constraints play a role in how a movement is executed in a specific environment. In their quest to maintain scientific rigour, controlled laboratory experiments often overlook the influence of these interacting constraints, which in turn reduces the representativeness or generalizability of findings. For example, a right jab in boxing completed during an actual match is subject to a number of constraints, such as the pressure from an opponent who is returning punches, time restrictions on the round (task) and the stress of competition (environmental). However, if an individual is tested in a laboratory setting these constraints that are present during competition are often not present, contributing to different movement patterns being displayed (Davids, Button, & Bennett, 2008). This is not to say that empirical studies are useless, but rather to highlight the potential

contribution of coaches' experiential knowledge to strengthen the current field of knowledge and support current findings from a contextual perspective that is often not attained in controlled laboratory-based settings.

The Elite coaches' experiential knowledge has often been developed over decades that are comprised of experiences accrued across a range of environments (e.g. practice and competition) (Coyle, 2009). Contrary to laboratory-based research, experiential knowledge of skilled movements patterns is developed over a range of environmental contexts. This is a major strength of experiential knowledge where coaches can develop a model of skilled movement from representative information sources (competition and practice). This signifies the applied value of experiential knowledge, as coaches develop knowledge of their sport, they start to identify patterns in performance (e.g. footwork is important for an effective punch) that lead to certain beneficial outcomes. A number of studies suggest that coach knowledge presents an opportunity to investigate the relationship between expert experiential knowledge and important biomechanical elements of a movement (Greenwood, et al., 2012; Jones, Bezodis, & Thompson, 2009). Subsequently, the aim of this study is to analyse experiential knowledge of elite boxing coaches to better understand how their knowledge compares to existing biomechanical research of effective punching and to identify underrepresented areas in the literature. By investigating experiential knowledge and its' relationship with findings from more controlled experimental research, this will help support and develop our existing understanding of punching performance.

Methods

Study positioning

The co-authors primarily adopt an interpretivist epistemological position (i.e. focus on how people make sense of their reality and derive meaning from it) in order to maintain a specific focus on the subjective reality of the coaches from their perspective, contextualised within the performance environment, and acknowledge the inherent biases that are introduced by the co-authors into the interpretation of the data. Therefore, being grounded in an interpretivist paradigm informed the methodological decision to use semi-structured interviews in order to explore and understand the subjective experiences of effective punching, as contextualised within the boxing performance environment (Flick, 2014).

Participants

Five New Zealand-based professional and amateur boxing coaches were interviewed for this study. The coaches all came from English speaking backgrounds and had lived in New Zealand for at least five years at the time of the interviews. Three of the five coaches had experience coaching in national programs outside of New Zealand, two in Europe and one in Australasia. Coaches were deemed as being expert by fulfilling three criteria: experience, achievement, and qualification. Firstly, 10 years of boxing coaching experience were required for coaches to be involved in this study. Second, coaches needed to be certified as amateur coaches during their career (certified by the International Boxing Association). Finally, the coaches needed to have coached at least one senior national champion. This criterion was adapted from similar studies that have investigated expert coaches (Cote et al., 1995; Thompson et al., 2009). Coaches that

participated in this study were selected using purposeful sampling, which requires participants to be selected based on specific qualities (i.e. coaching experience, achievement etc) related to the overall topic being explored (Patton, 2002). Written consent was gained before the commencement of data collection. All procedures carried out in this study were approved by the Auckland University of Technology Ethics Committee.

Data Collection and analysis

Semi-structured, in-depth interviews were conducted with each coach to determine key technical features for an effective punch. As per Patton (2002), follow-up questions and detail-oriented probes were used to clarify the meaning of the responses given. The interviews were separated into two sections, an introductory section exploring the coaches' history in the sport, and a technical section focused on the specifics of what they deem an 'ideal punch.' The introduction section was primarily used in this study to improve the communication between the coaches and the interviewer (Patton, 2002). Findings from this section were not included in this manuscript, due to their non-relevance regarding the research question. The results of the second section were used in the analysis. These questions were focused on exploring coaches' knowledge through multiple sensory pathways, i.e. questions were asked about how landing a punch felt, what it looked like, and what it sounded like (Coté, Saimela, Trudel, Baria, & Russell, 1995). The interviews took approximately 45 to 80 minutes to complete, depending on the individual coach's willingness to expand on topics and their general talkativeness. Despite the variation in the length of interviews, it was made certain that the key topics were discussed in adequate depth.

The interviews were all digitally recorded and then transcribed verbatim by the primary investigator. During the transcription process, all identifying information was scrubbed to maintain anonymity of the coaches. In line with similar studies, sentence-by-sentence open coding was conducted by the primary researcher to identify raw data themes. Identified themes comprised of quotations from coaches' forming units for further analysis. Themes constructed from the interviews were separated and categorised used coding. This resulted in first and second order themes being established. A first order theme was established if it met the criteria of being discussed most frequently by all five coaches, in relation to effective punching. Subsequently, themes were classified as being second order when at least three of the coaches discussed it.

To cultivate trustworthiness and enhance credibility, a second peer reviewer was employed to theme the transcripts in parallel with the primary investigator (Côté, Salmela, Baria, & Russell, 1993). After sentence-by-sentence open coding (Coté et al., 1995), the two reviewers met to discuss their findings and find agreement on incongruent findings. Finally, triangulation of the qualitative findings was performed with an expert reviewer (Marshall & Rossman, 2014), who debriefed the investigator and helped refine the final themes. As in similar studies, analysis was an iterative process where concepts were subject to continual evaluation. As a result, confidence in the concepts' validity was developed (Jones. R., Bezodis, & Thompson, 2009; Thompson, Bezodis, & Jones, 2009b).

Results

The results in this section were focused on the coaches' technical analysis of effective punching. This section was constructed from first order themes identified and expanded with frequent terms and quotes. To avoid author bias, the findings are presented as given by the coaches, with no reference to the current literature regarding punching biomechanics. Triangulation between the findings in this section and the current literature was performed in the discussion (Marshall and Rossman, 2014). There was a consensus among the five coaches interviewed as to the key elements of effective punching. The four first order themes identified from this consensus were: 1) 'whole body movement,' 2) 'footwork,' 3) 'hip and shoulder rotation,' and 4) 'hand and arm position.'

Whole Body Movement

Coach 1 (C1): 'You might be able to throw a jab without taking a forward movement, like a static punch, but it's never going to be as effective as if you've timed it with your foot work. Stepped in with a shot.'

C4: '…you got to put the body weight in behind the punch, and you effectively try and stab the person with your punch.'

A concept identified by all of the coaches interviewed was that when punching for optimal force, rather than strategic use (Walsh, 1951), a boxer needs to move their entire body weight forward, into the target, in a fluid manner. This concept was found to be interrelated with the higher-order themes of 'footwork' and 'hip and shoulder rotation.' 'Whole body movement' differed from the inter-related themes in that the coaches explained the other themes could be used in a variety of circumstances, while 'whole body movement' was used in attacking actions. The coaches spoke of 'body weight/weight of the body' moving forward in a 'fluid' and 'in sync' manner. The coaches pointed out flawed technique as the opposite of this. Using the term 'arm punches,' they identified a lack of body movement when punching, noting that these poor technique punches relied instead on the strength of the arm to produce force: a sub-optimal strategy for forceful striking. In the context of the sub-optimal arm punching example, 'whole body movement' is the concept of summating the mass and muscles of the body to produce greater force during impact (Dempsey, 1950).

Footwork

C2: 'Most of the force is generated from the legs. From the feet up.'

C3: '…the force, the weight of the body behind the shot, you know it's stated that at least 70% of the force in the punch comes from below the waist line…'

The concept of 'footwork' in effective punching was separated into two components by all the coaches interviewed: 'balance' and 'pushing' off the feet. 'Balance' was described similarly to the concept of balance as understood in the literature, the ability to maintain equilibrium under explicit conditions (Gamble, 2012). Specific to boxing, the maintenance of balance was explained as the need to, 'Step with a punch. One punch, one step.' (C1). The relationship to 'whole body movement' is clear here, but with the additional focus of remaining 'stable' and 'balanced' for continuing attacks and to avoid leaving the boxer vulnerable to 'counter attack.'

'Pushing' off the feet was clearly identified by all coaches as the key to producing punching force. There was variability in the exact description of the ideal technique used when 'pushing' off the feet. Several coaches referred to a 'push' from the feet to propel a step (two coaches), while others referenced a 'push' to 'rotate the heel' laterally (two coaches), while one coach thought of the push more linearly, a drive forward into the target at impact. This variability could be a result of differences in the actual technique instructed by the coaches or could be a simple semantic disagreement. Regardless, the concept identified by all coaches was that the foot 'push' was the key to producing effective punching force. Moreover, when asked for a principal coaching cue to give to a boxer for the improvement of punching force, all coaches provided the same answer, identifying 'footwork' as that cue above all others.

Hip and shoulder rotation

C1: 'I personally think that you'll be seeing the guys that get full rotation of the hips will land the better shots.'

C3: '…so if you don't use a rotation, that is you don't rotate your body, so that both hip and shoulders come around behind the shot, then it is only an arm punch.'

Rotation of the hips and shoulders during punching was identified by the coaches interviewed as crucial to effective punching. The concept was explained as a rotation of the hip and shoulder towards the intended target. For example, if throwing a rear hand right punch, the right hip and the right shoulder would rotate towards the target. This, combined with a step or 'push' from the lower body's 'footwork,' were the two primary components of the 'whole body movement' theme. Not only moving the body forward but bringing more of the body into play and avoiding 'arm punches.' This movement was also recognized by the coaches as initiated by a 'push' from the feet used to rotate the hip around, followed by the shoulder, and finally the hand.

C5: 'So it's a build-up and then a completion, in a timed manner which will equate to strong force at a certain point.'

The explanation of the rotation was crutched around the idea that a boxer must be careful not to over rotate, putting themselves in a dangerous position, echoing the concept of 'balance' in the above sub-section.

Hand and arm position

C4: 'Where the punch comes from is probably as important from a defensive perspective, because if you are throwing arm punches from your shoulders or your hips, it's clearly not from your face, so you are going to get f***ing caught sooner or later.'

C5: 'Bad technique when they're not bringing their shoulder up to protect their chin and give more power to the punch...'

The positioning of the hand and arm, as indicated by the coaches, was broken down into two primary concepts: a defensive focus on using the hand and arm to protect the boxer and a focus on striking with correct hand position to maximize force.

Specific to defence, the coaches spoke to a need to 'avoid dropping their hands.' Keeping the 'hands up' allows a boxer to 'catch' incoming punches with the hands and bring the arms up to 'guard' against incoming punches (Slack, 2012). The positioning of the hands and arm for defence can be conceptualized as both an intermediate component of punching, important before and after strikes are thrown, and an active part of a punch to protect the boxer in the case when both fighters are punching simultaneously (Slack, 2012).

Hand position was described by the coaches as a combination of hand elevation in relation to the elbow and a rotation of the hand moments before impact. Elevation of the hand was simply described as follows, 'Your hand must be above your elbow' (C3) and was explained to be one way to allow for the hand to 'turn over' pre-impact. It was clarified that this point was only for punches in a horizontal attack (straight punches and hooks), not for vertical strikes (uppercuts).

'Turning the hand over' was identified by C4 as actively 'pronating the hand' during the punch. The coach (C4) stated that by performing this action, a boxer can 'get a bit more extra reach' and, as stated by another coach, it is active in 'pulling your shoulder around' (C3). This statement links the hand to shoulder rotation, and thus, 'whole body movement.'

Discussion

Using semi-structured interviews, rich data was extracted from the experiences of expert coaches on punching performance. This methodological approach allowed for the cultivation of key technical aspects of punching performance that were contextualised within the boxing performance environment. Findings from the interviews revealed four principal components that coaches associate with effective punching performance: 1) whole body movement; 2) footwork; 3) hip and shoulder rotation; 4) hand and arm position. Conflicting reports were evident in the coaches' exact descriptions of the actions of punching within the principal components. This highlights the subjective nature of this approach and how coaches bring their own biases to the way they interpret effective performance. These differing accounts could be explained by the difference in years of coaching experience, approaches to professional development, and the level of athletes being coached. Furthermore, these differences could have emerged as a result of variations between coaches' internal biomechanical models of effective punching performance. These findings suggest the importance of coaches investing time into the development of their biomechanical knowledge of performance and to address gaps in technical models of movement.

A hierarchy of the first order themes (principal components of effective punching) was identified through the analysis of the interview data obtained from the study participants. Effective punching was structured hierarchically under the umbrella of the whole body movement theme. The themes of footwork, hip and shoulder rotation, and hand and arm position all combined to produce the body movement assigned by the coaches to produce effective punching. Furthermore, under the whole body movement umbrella a

clear hierarchy was also identifiable. Footwork was clearly indicated by all coaches as the starting point, propelling the body forward, and a dominant component in executing whole body movement; for example, initiating the torque used to rotate the hip and shoulder. Proper footwork does this in a manner facilitating balance, permitting continued attacks or defensive actions. Initiated and produced by footwork, the hip rotation continues up the kinetic chain and producing shoulder rotation, as explained by the coaches. The shoulder rotation in turn affects, and is affected by, the movement of the arms. When positioned correctly, the arm and hand enable the continuation of the shoulder rotation and application of force into the target: a foot to hand movement bringing the entirety of the body into a single application of force.

Expert coaches identified whole body movement as contributing to effective punching performance. Current literature exploring punching is consistent with these findings. For example, Neto et al. (2007) found effective mass to be crucial to effective punching. The concept of effective mass in combat sports has been simplified in earlier works as a calculation of the inertial contribution of the fighter in a punch (Lenetsky, Nates, Brughelli, & Harris, 2015). As such, it is likely that the greater whole body movement, the greater the inertial contribution; the greater the inertial contribution, the greater the effective mass; the greater the effective mass, the more effective the strike. McGill et al. (2010) first theorized that specific muscular adaptation, which results in reducing compliance in the musculoskeletal system, leads to increases in effective mass. There is a conflicting theory, arguing that effective mass is heavily influenced by the drive from the lower body during impact (Lenetsky et al., 2015). The lower body drive theory is affirmed by the coaches' insight; however, further research is required to confirm these findings.

Cesari and Bertucco (2008) identified several findings in their study of novice and expert karate practitioners (karateka) that linked effective punching to the theme of whole body movement. The authors found that, beyond greater punch impulse, expert karateka potentially had more anterior displacement of their centre of pressure (COP) than novice practitioners (a non-significant finding) and that the experts had greater upper limb displacement during the punch. The authors suggest that the upper limb displacement was used to commit an 'extra amount of upper limb mass' to the impact.

Continuing down the hierarchy of effective punching, footwork, specifically pushing with footwork, was investigated by Filimonov and colleagues (1983) who found greater contribution from the lower body in experienced boxers and those were indicated to be stronger punchers. Loturco et al. (2014) reinforced the importance of pushing with footwork through their linking of punch acceleration to propulsive power during jump squat testing (r=.80) in karateka. The propulsive power of the jump squat had the highest correlation of all measures, including upper body power measures and lower and upper body strength measures. More recently, Loturco et al. (2015) performed a similar study on experienced boxers and found similar results (r=.85) when comparing mean propulsive power in jump squats to punching impact force. Training studies have found that increases in maximal strength (both lower and upper) produce statistically meaningful increases in punching force, 12.4-21.1%. Due to the limited literature at the time, Lenetsky et al. (2013) reviewed movements similar to punching to provide insight to their review of contributors to punching force. Their findings further reinforce those above and those indicated by the coaches interviewed. Of note, the authors bring attention to the findings of Stodden et al. (2006), who found a boxing specific

contralateral step increased ball speed when compared to a static throw. This step is much like the one proposed by C1 above.

Due to limited research investigating coaches' knowledge of the punch, specifically balance in relation to footwork when punching, it is difficult to draw parallels to any existing research. However, a single study showed that experienced karateka undertook less of a COP shift backwards after impact when compared with novice practitioners (Cesari & Bertucco, 2008). This finding supports coaches' reports from the current study regarding the use of balance to facilitate continued attack. A shift backwards would necessitate a return to the forward position before any additional attacks could occur. Overall, the literature relating to pushing and balance provides strong evidence confirming the importance of footwork for effective punching, as stated by our cohort of experienced coaches.

The current study highlighted an existing gap in research around hip and shoulder rotation in punching, as described by the coaching cohort in this study. Of those explored, there were no comparative studies of different levels of combat sport athlete or training studies found. In one of the few descriptive studies located, hip and shoulder rotation was defined as a method of transferring the forces produced by the lower body, up the kinetic chain, and into the target (Tong-Iam & Lawsirirat, 2016). An analysis of a European boxing champion highlights this transfer, as velocity measures at the hip, trunk, and arm increased up the kinetic chain as punching movements were executed: (hip = 765.19°.S^(-1) ± 29.49, trunk = 866.69°.S^(-1) ± 42.54, arm = 1404°.S^(-1) ± 102.23) (Cabral, Joao, Amado, & Veloso, 2010). In addition to a method of summating velocity, the limited literature also reinforces the concept of hip and shoulder rotation as a strategy used to shift a combat sport athlete's weight forward into a target. Cheraghi et al. (2014) postulated that their findings of anterior hip displacement in amateur boxers were used to shift the fighters' body weight forward, into the target.

Research on the importance of hip and shoulder rotation in punching performance is scarce, making it difficult to link coaches' expert knowledge to empirical findings on effective punching performance. However, this gap emphasises the importance of studies like this one and its usefulness in directing future research by highlighting areas of performance that require more attention in future interventions.

Current literature supports the positioning of the hand and arm in punching that was described by the coaches interviewed in this study. 3D kinematics of straight and hook punches found an elevation of the wrist above the elbow, as described by the coaches (Whiting, Gregor, & Finerman, 1988). In conjunction with the elevated wrist, Morita et al. (2011) pinpointed a rotation of the wrist in the same plane, as again explained by the experienced coaches. Much like the hip and shoulder rotation literature, no research was found that compared 'good' and 'bad' kinematics in relation to the variables provided by the coaches. As such, only the few descriptive studies found were used for triangulation. No literature was found exploring the kinematics of defensive actions using hand and arm position in combat sports. The importance of such defensive actions has been well established in boxing specific writing (Dempsey, 1950; Lee, 1975; Slack, 2012). Still, the lack of peer reviewed literature in relation to our findings from the thematic interviews stands out as another gap in the literature that needs examination in future studies.

The aim of this study was to explore experiential coaching knowledge to identify key technical parameters that elite boxing coaches associate with effective punching technique and better understand how their knowledge compares to existing biomechanical research on punching mechanics. The triangulation of the findings from the coaches' interviews with the current information available from combat sport literature clarifies many of the themes identified and serves to highlight current gaps in knowledge. Combining the themes found in the current study and findings in the literature serve to break down punching from a whole body movement, to a combination of footwork, enabling proper rotation, finally leading to a properly thrown hand landing on target. The paramount importance of footwork was identified as the initiator of the punch, rotation, and potentially a key in transmitting greater inertia during impact. The themes of hip and shoulder rotation and hand and arm position were connected to kinematic findings; although, the paucity of experimental research in the area leaves much to be understood regarding the exact technique needed to maximize punching performance. Through our triangulation, specific gaps in the literature include: a further understanding of footwork in the initiation of punching actions; the role of the lower body during impact; the relationship of hip velocity to punching kinetics; the kinematic impact of turning the hand over while punching; and, the precise kinematics of effective defensive using the hand and arm position.

Limitations

The primary limitation of this study was the homogeneity of the sample. New Zealand is a relatively small nation in which boxing is a minority sport, overshadowed by national past times such as Rugby Union. As such, many of the coaches interviewed spent extensive time working together, developing as junior coaches with each other, and potentially under each other's guidance in a small community that may have homogenised views on the sport. This potential limitation could result in the relative congruity found in our results. Although, we must also acknowledge the international work performed by many of these coaches, which exposed them to training methodology and concepts outside of those found in New Zealand. This idea is further reinforced by the fact that the identified themes were consistent with empirical evidence on effective punching technique found in the literature (triangulation) and indicate the veracity of the study, notwithstanding the homogenised sample.

Conclusion

Expert coaches are uniquely positioned to develop knowledge of movement performance that is displayed over a range of environmental contexts. Interview data showed that all coaches agreed that the key attributes related to effective punching were, 'whole body movement,' 'footwork,' 'hip and shoulder rotation,' and 'hand and arm position.' These first order themes were consistent with current empirical knowledge of punching technique in boxing. The consistency displayed between the current findings and the current literature highlights the value of experiential knowledge to support findings from more controlled laboratory-based experimentation. Furthermore, present findings show the importance of researching coaches' experiential knowledge to identify gaps in the existing body of research. This was observed in the present data set with second order themes being triangulated with the current research. 'Pushing' off with the legs, maintaining 'balance,' rotating the hips and shoulders, keeping the hands elevated, and 'turning the hand over' were all supported with quantifiable data. These second order themes highlighted areas that have

yet to be investigated in the literature. These gaps being the details of the lower body's role in initiating the punch, the role of the lower body during impact, and the kinematic impact of the hip, shoulder, arm, and the hand in effective punching. While there was agreement in the general themes, there were exact technique cues presented by individual coaches that did not have agreement within the cohort. These disagreements, interestingly, fell primarily within the unsubstantiated second order themes. Such results guide the way for future investigations, specifically in terms of developing research that gives voice to experiential data of expert coaches, where this data can be used in conjunction with current theory to enhance knowledge of effective punching in combat sports.

References

Atha, J., Yeadon, M. R., Sandover, J., & Parsons, K. C. (1985). The damaging punch. British Medical Journal, 291(21 - 28), 1756 - 1757.

Burwitz, L., Moore, P. M., & Wilkinson, D. M. (1994). Future directions for performance-related sports science research: An interdisciplinary approach. Journal of Sports Sciences, 1(12), 93 - 109.

Cabral, S., Joao, F., Amado, S., & Veloso, A. (2010). Contribution of trunk and pelvis rotation to punching in boxing. Paper presented at the Conference Proceedings of the Annual Meeting of the American Soc.

Carrier, D. R. (2011). The advantage of standing up to fight and the evolution of habitual bipedalism in hominins. Plos One, 5(6).

Carrier, D. R., & Morgan, M. H. (2014). Protective buttressing of the hominin face. Biological Reviews, 90(1), 330 - 346.

Cesari, P., & Bertucco, M. (2008). Coupling between punch efficacy and body stability for elite karate. Journal of Science and Medicine in Sport, 11(3), 353 - 356.

Cheraghi, M., Alinejad, H. A., Arshi, A. R., & Shirzad, E. (2014). Kinematics of straight right punch in boxing. Annals of Applied Sport Science, 2(2), 39 - 50.

Coté, J., Saimela, J., Trudel, P., Baria, A., & Russell, S. (1995). The coaching model: A grounded assessment of expert gymnastic coaches' knowledge. Journal of Sport and Exercise Psychology, 17(1), 1 - 17.

Côté, J., Salmela, J. H., Baria, A., & Russell, S. J. (1993). Organizing and interpreting unstructured qualitative data. The Sport Psychologist, 7(2), 127 - 137.

Coyle, D. (2009). The talent code: Unlocking the secret of skill in maths, art, music, sport, and just about everything else: Random House.

Davids, K., Button, C., & Bennett, S. (2008a). Dynamics of skill acquisition. [electronic resource]: a constraints-led approach: Champaign, IL: Human Kinetics, c2008.

Davids, K., Button, C., & Bennett, S. (2008b). Physical constraints on coordination: Dynamical systems theory Dyamics of skill acquisition: A constraints-led approach. Champaign, IL: Human Kinetics.

Dehghansai, N., Headrick, J., Renshaw, I., Pinder, R. A., & Barris, S. (2019). Olympic and Paralympic coach perspectives on effective skill acquisition support and coach development. Sport, Education and Society, 1-14. doi:10.1080/13573322.2019.1631784

Dempsey, J. (1950). Championship Fighting: Explosive Punching and Aggressive Defense. Long Beach, CA: Centerline Press.

Filimonov, V. I., Koptsev, K. N., Husyanov, Z. M., & Nazarov, S. S. (1983). Means of increasing strength of the puunch. National Strength and Conditioning Association Journal, 7(6), 65 - 66.

Flick, U. (2014). An introduction to qualitative research: Sage.

Girodet, P., Vaslin, P., Dabonneville, M., & & Lacouture, P. (2005). Two-dimensional kinematic and dynamic analysis of a karate straight punch. Computer Methods in Biomechanics and biomedical Engineering, 8(S1), 117 - 118.

Greenwood, D., Davids, K., & Renshaw, I. (2012). How Elite Coaches' Experiential Knowledge Might Enhance Empirical Research on Sport Performance. International Journal of Sports Science & Coaching, 7(2), 411-422. doi:10.1260/1747-9541.7.2.411

Halperin, I., Chapman, D. W., Martin, D. T., Lewthwaite, R., & Wulf, G. (2016). Choices enhance punching performance of competitive kickboxers. Psychological Research, 1 - 8.

Jones, R., Bezodis, I., & Thompson, A. (2009). Coaching sprinting: expert coaches' perception of race phases and technical constructs. International Journal of Sports Science & Coaching, 4(3), 385-396.

Jones. R., Bezodis, I., & Thompson, A. (2009). Coaching sprinting: Expert coaches' perception of race phases and technical constructs. International Journal of Sports Science & Coaching, 4(3), 385 - 396.

Lee, B. (1975). Tao of Jeet Kune Do. Santa Clarita, CA: Ohara Publications.

Lenetsky, S., Harris, N., & Brughelli, M. (2013). Assessment and contribution of punching forces in combat sports athletes: Implications for strength and conditioning. Strength and Conditioning Journal, 35(2), 1 - 7.

Lenetsky, S., Nates, R. J., Brughelli, M., & Harris, N. K. (2015). Is effective mass in combat sports punching above its weight? Human Movement Science, 40, 89 - 97.

Loturco, I., Artioli, G. G., Kobal, R., Gil, S., & Franchini, E. (2014). Predicting punching acceleration from selected strength and power variables in elite karate athletes: A multiple regression analysis. Journal of Strength and Conditioning Research, 28(7), 1826 - 1832.

Loturco, I., Nakamura, F. Y., Artioli, G. G., Kobal, R., Cal Abad, C. C., Cruz, I. F., . . . Franchini, E. (2015). Strength and power qualities are highly associated with punching impact in elite amateur boxers. Journal of Strength and Conditioning Research, 30(1), 109 - 116.

Marshall, C., & Rossman, G. B. (2014). Designing qualitative research (6th Ed.): Sage.

McGill, S. M., Chaimberg, J. D., Frost, D. M., & Fenwick, C. M. J. (2010). Evidence of a double peak in muscle activation to enhance strike speed and force: An example with elite mixed martial arts fighters. The Journal of Strength and Conditioning Research, 24(2), 348 - 357.

Mears, A., Roberts, J., Wallace, E., Kong, P., Forrester, S., Mackenzie, S., & Robertson, S. (2015). Golf Coaches' Perceptions of Key Technical Swing Parameters Compared to Biomechanical Literature. International Journal of Sports Science and Coaching, 10, 739-756. doi:10.1260/1747-9541.10.4.739

Morgan, M. H., & Carrier, D. R. (2013). Protective buttressing of the human fist and the evolution of hominin hands. The Journal of Experimental Biology, 2(216), 236 - 244.

Morita, M., Watanabe, K., Kobayashi, K., & Kurihara, Y. (2011). Boxing punch anaylsis using 3D gyro sensor. Paper presented at the SICE Annual Conference.

Neto, O. P., Magini, M., & Saba, M. M. F. (2007). The role of effective mass and hand speed in the performance of kung fu athletes compared with nonpractitioners. Journal of Applied Biomechanics, 23(2), 139 - 148.

Newell, K. (1986). Constraints on the development of coordination. Motor development in children: Aspects of coordination and control.

Patton, M. (2002). Qualitative research and evaluation methods (3rd ed.). Thousand Oaks: Sage.

Reider, B. (2004). Battle scars. The American Journal of Sports Medicine, 42(6), 1287 - 1289.

Slack, J. (2012). Elementary Striking (1st Ed.): Self.

Spencer, D. C. (2009). Habit(us), body techniques and body callusing: An ethnography of mixed martial arts. Body & Society, 15(4), 119 - 143.

Stodden, D. F., Langendorfer, S. J., Fleisig, G. S., & Andrews, J. R. (2006). Kinematic constraints associated with the acquisition of overarm throwing part I: Step and trunk actions. Research Quarterly for Exercise and Sport, 77(4), 417 - 427.

Thompson, A., Bezodis, I. N., & Jones, R. L. (2009a). An in-depth assessment of expert sprint coaches' technical knowledge. Journal of Sports Sciences, 27(8), 855-861.

Thompson, A., Bezodis, I. N., & Jones, R. L. (2009b). An in-depth assessment of expert sprint coaches' technical knowledge. Journal of Sport Sciences, 27(8), 855 - 861.

Tong-Iam, R., & Lawsirirat, C. (2016). X-factors in straight punched. Paper presented at the ISBS-Conference Proceedings Archive.

van Bottenburg, M., & Heilbron, J. (2006). De-sportization of fighting contests. International Review for the Sociology of Sport, 3-4(41), 259 - 282.

VencesBrito, A. M., Ferreira, M. A. R., Cortes, N., Fernandes, O., & Pezarat-Correia, P. (2011). Kinematic and electromyographic analyses of a karate punch. Journal of Electomyography and Kinesiology, 21(6), 1023 - 1029.

Walilko, T. J., Viano, D. C., & Bir, C. A. (2005). Biomechanics of the head for olympic boxer punches to the face. British Journal of Sports Medicine, 39(10), 710 - 719.

Walker, J. D. (1975). Karate strikes. American Journal of Physics, 43(10), 845 - 849.

Waters, A., Phillips, E., Panchuk, D., & Dawson, A. (2019). Coach and biomechanist experiential knowledge of maximum velocity sprinting technique. International Sport Coaching Journal, 6, 1-15. doi:10.1123/iscj.2018-0009

Whiting, W. C., Gregor, R. J., & Finerman, G. A. (1988). Kinematic analysis of human upper extremity movements in boxing. The American Journal of Sports Medicine, 16(2), 130 - 136.