Müller, S., van Rens, F., Brenton, J., Morris-Binelli, K., Piggott, B., Rosalie, S. M., & Burgin, M. (2019). Embedding of psycho-perceptual-motor skills can improve athlete assessment and training programs. *Journal of Expertise, 2* (1), 14-22.

Journal of Expertise
2019. Vol. 2(1)

ISSN 2573-2773

Embedding of Psycho-Perceptual-Motor Skills Can Improve Athlete Assessment and Training Programs

Sean Müller[1], Fleur van Rens[1], John Brenton[1], Khaya Morris-Binelli[1], Benjamin Piggott[2], Simon M. Rosalie[3], and Matthew Burgin[4]
[1]Discipline of Exercise Science, Murdoch University, Australia
[2]School of Health Science, University of Notre Dame, Australia
[3]School of Physiotherapy and Exercise Science, Curtin University, Australia
[4]Western Australia Cricket Association, Australia

Correspondence: Sean Müller, s.muller@murdoch.edu.au

Abstract
Practitioners in a variety of sports seek unique ways to train athletes to better prepare them for competition. In this position paper, we argue that inclusion of psycho-perceptual-motor skills, from the fields of sport psychology and sport expertise, is crucial, but underutilized in the assessment and training of athletes. First, a brief introduction is provided as to why psycho-perceptual-motor skill is vital for training athletes. Second, examples are discussed relating to key concepts. These include the following: assessment of expertise discriminators such as visual anticipation under pressure contexts, incorporation of sports analytics and performance analysis to aid reflection upon previous experiences of good anticipation and coping with pressure, use of qualitative and quantitative measures to understand processes underlying performance and learning, as well as design of representative tasks for assessment and training anticipation under pressure contexts. Third, some recommendations are made to practitioners of sports teams to assist them in taking advantage of psycho-perceptual-motor skill to better prepare athletes for competition. Collectively, we hope this paper stimulates collaboration between practitioners of sports teams and scientists to create a greater focus upon integrated sport psychology and sport expertise in the training of athletes.

Keywords
sport psychology, sport expertise, sport psychologist, skill acquisition specialist, psycho-perceptual-motor skill

Introduction

Sporting organizations commonly focus their resources for athlete assessment and training programs on physical components of sport performance such as strength, speed, agility, flexibility and motor skill execution (Johnston, Wattie, Schorer, & Baker, 2018). It is far less common for sporting organizations to allocate comparable resources to assess and train the athletes' psychological and perceptual-cognitive-motor (*psycho-perceptual-motor*) skills (Steel, Harris, Baxter, King, & Ellam, 2014; Zaichkowsky & Peterson, 2018). However, sports coaches argue that superior psycho-perceptual-motor skills discriminate superior sports performance (Zaichkowsky & Peterson, 2018), and that improvement of these skills can also facilitate superior sports performance (Steel et al., 2014). This implies that both amateur and professional athletes can benefit from assessment and training to improve psycho-perceptual-motor skills. Therefore, a rich opportunity exists for scientists and practitioners to work together to improve psycho-perceptual-motor skills of athletes across amateur and professional sports.

In this position paper, we argue that psycho-perceptual-motor skills should be further embedded in the assessment and training programs of athletes. To illustrate this point, the paper is structured into three sections. First, a brief background of sport psychology and sport expertise is provided to explain the role of scientists and practitioners from these fields. Second, examples are discussed of where scientists and practitioners can collaborate further to assess and train athletes. This discussion is focused on factors that discriminate performance of expert perceptual-cognitive-motor skill, as well as those that facilitate skill learning and transfer (Morris-Binelli & Müller, 2017; Williams, Ford, Hodges, & Ward, 2018). Finally, we make recommendations of how practitioners can utilize psycho-perceptual-motor skills to assess and train athletes. It is hoped that administrators and practitioners in the sports industry will consider the messages presented in this paper as an opportunity to foster stronger interdisciplinary collaborations between scientists and practitioners.

A Brief Background of the Science and Application of Sport Psychology and Expertise

Sport psychology concerns cognitive processes and psychological skills that underpin sports performance (Abernethy et al., 2013). Take for example a field hockey goalkeeper facing off against a drag-flicker in a stadium full of screaming fans with scores tied and one minute remaining in the match. In a scenario such as this, the goalkeeper's (psychological) skill in coping with pressure will determine whether their expertise will fail them. Sport psychology researchers are interested in understanding the mechanism(s) of cognitive processes, and interactions with situational demands, which affect athletes' attainment of motor skill goals, such as saving goals (e.g., see Woodman, Barlow, & Gorgulu, 2015). Furthermore, sport psychology practitioners are interested in implementing effective interventions that facilitate attainment of these motor skill goals under high pressure (Rumbold, Fletcher, & Daniels, 2012). Research indicates that dependent on intervention design features, a variety of stress management interventions may enhance sport-specific skills in high-pressure situations (Rumbold et al., 2012).

Sport expertise and motor skill learning is a field of study that falls under the sub-discipline of motor control and learning, which is part of human movement science (Abernethy et al., 2013). Sport expertise researchers are interested in understanding the mechanism(s) that underpin expert perceptual-cognitive-motor skill performance and factors that discriminate expert performance in sport (Williams et al., 2018). In addition, sport expertise researchers are interested in the mechanism(s) that underpin practice structure, instruction and feedback that can facilitate learning and transfer of perceptual-cognitive-motor skill in sport (Williams et al., 2018). In the example of a field hockey goalkeeper who attempts to save a drag flick, the sport expertise researcher would be interested in how the goalkeeper reads the drag flicker's body language (or kinematics) to anticipate the shot, thus providing them the time necessary to execute a save (e.g., see Baker, Farrow, Elliott, & Alderson, 2009). The skill acquisition practitioner is interested in how to implement interventions in the form of perceptual-cognitive-motor skill practice designed to improve skills such as anticipation in sports-specific settings (Steel et al., 2014).

Based on the above, we believe that sport psychology and sport expertise concepts are intricately integrated in sports skills. In addition, practitioners and scientists in sport psychology and expertise may use a variety of technologies to assist their research and practice. In the next section, we discuss examples of how scientists and practitioners can collaborate, as well as use different technologies, to assess and train athletes' psycho-perceptual-motor skills.

How Can Scientists and Practitioners Assess and Improve Psycho-Perceptual-Motor Skills?

Discriminators of Sport Expertise

A key skill that has been consistently reported to discriminate expertise in sport is anticipation. Visual anticipation refers to the capability of an athlete to use situational context (e.g., game score and opponent action tendency), opponent movement pattern (kinematic), and object flight information to predict future opponent behavior or game state (Morris-Binelli & Müller, 2017; Williams & Jackson, 2019). For example, this includes a baseball batters use of the pitch count to determine the probability that a pitcher will throw a specific pitch type (e.g., Gray, 2002), combined with the pitcher's kinematics and ball flight cues (e.g., Müller, Fadde, & Harbaugh, 2017), to anticipate which pitch will be thrown. Anticipation is also important when "reading the play" in open-play sport contexts such as soccer or field hockey in order to determine whether to pass, retain possession of, or shoot the ball at goal (Gorman, Abernethy, & Farrow, 2011; Williams, Ward, Ward, & Smeeton, 2008).

A common method used to measure anticipation is the temporal occlusion paradigm applied to video footage or achieved through player-worn spectacles. In the video method, sports-specific footage of an opponent (e.g., pitcher) or open field play is filmed and then edited to include a black video frame at selected time points in the sequence (e.g., point of ball release). The edited footage is then displayed to the performer (e.g., baseball batter) on a projection screen, laptop, or mobile phone with the performer required to watch until the point of temporal occlusion and anticipate what will occur with a verbal, button press or sports-specific motor response. In the spectacles method, typically, the performer (e.g., batter) wears the spectacles and faces an opponent (e.g., pitcher) who executes a stimulus skill (e.g., pitching a fastball or a change-up) in a field-based setting. The scientist or practitioner can remotely control the spectacles to allow the batter to see the pitcher's wind-up until the point of ball release, with no further vision of ball flight. The batter is then required to anticipate the pitch using a verbal, part sports-specific response, or response to attempt to strike the ball.

Research using video simulation and field-based tests have indicated that experts are superior to less skilled players at using situational (Abernethy, Gill, Parks, & Packer, 2001; Runswick, Roca, Williams, McRobert, & North, 2018a) and kinematic (Causer, Smeeton, & Williams, 2017; Müller et al., 2009) information to anticipate. When situational information is incongruent with kinematic information, anticipation ability decreases across players of different skill levels, but to a lesser magnitude in expert players (Runswick, Roca, Williams, McRobert, & North, 2018b). In addition, research indicates that near-experts are less able to pick-up kinematic and ball flight information for anticipation in comparison to experts (Müller et al., 2017; Rosalie & Müller, 2013). To our knowledge, however, there is no scientific understanding of individual differences in how emerging experts (e.g., state, provincial or international squad players) and well-established experts (state or international players) use situational and kinematic information for anticipation.

Sport expertise researchers have begun to integrate sport psychology factors to better understand expertise in sport. The effect anxiety has on anticipation and perceptual-cognitive-motor skill has gained popularity. For example, in a field study where cricket batters faced bowlers in simulated games, findings indicated that higher anxiety had a greater detrimental effect upon the outcome of striking a ball (i.e., quality of bat-ball contacts), than visual search patterns (Runswick, Roca, Williams, Bezodis, & North, 2018). Knowing how psychological factors such as anxiety affect anticipation can guide design of tests to assess athletes' psycho-perceptual-motor skills under different conditions, and to design interventions to train athletes (see representative tasks section below).

Analytics, Performance Analysis and Psycho-Perceptual-Motor Skill

Sports analytics and performance analysis is a rapidly growing field with several professional teams employing a team of analysts to code player and opponent performances during competition (Zaichkowsky & Peterson, 2018). This data is used by coaches to prepare tactically to face an opposing team, as well as by individual athletes to prepare their perceptual-cognitive-motor skills for different opponents they may face in competition (Doo & Kim, 2018). Analytics data is a rich resource that can provide an insight into the psycho-perceptual-motor skill of athletes relative to their opposition under the highest of pressure contexts being competition (e.g., see Farrow, Whiteside & Reid, 2016). For example, coded video footage of athlete performance relative to a timeline of contexts during competition can be later used to reflect and prepare for future performance. This approach has been reported to be highly valuable in preparing elite athletes for competition (Fernandez-Echeverria, Mesquita, Conejero, & Moreno, 2019).

Here we provide a working example of the implementation of psycho-perceptual-motor skill analysis applied to cricket. In cricket, the score of the game is indicated by the amount of "runs" made by the batter. Figure 1 presents the progressive strike rate of an international cricket batter plotted against the progressive runs scored by the batter and team score during a Test cricket match. Strike rate is the number of runs a batter has made relative to the number of balls faced. Consequently, the strike rate provides a metric of how fast the batter scored their runs. Accordingly, a strike rate closer to 100 indicates faster scoring, between 50 to 70 indicates moderate scoring, and below 50 indicates slow scoring rates. In a Test cricket match, which can last up to five days, the objective is to bat for extended periods of time and score as many runs for the team as possible; there is less emphasis upon how fast the runs are scored when compared to other formats of cricket.

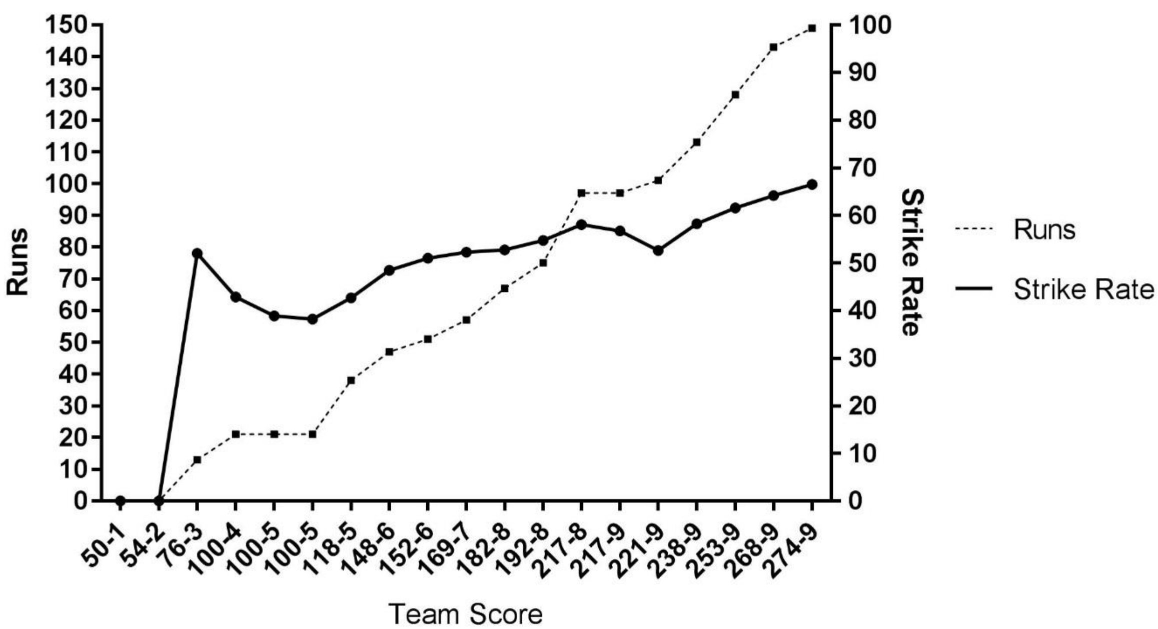

Figure 1. An international cricket batter's cumulative runs scored (left y-axis) relative to strike rate (right y-axis) and team score (x-axis) in a Test match innings. 50-1 refers to 50 runs scored by the team with 1 batter out and so forth for the remaining team scores.

The sport psychologist and skill acquisition specialist could use the data displayed in Figure 1 to reflect with a batter on how to construct their innings in order to score 50, 100, or more runs for the team. The following psycho-perceptual-motor skill factors could be discussed. First, the overall strike rate did not increase above 70, indicating a moderate speed of scoring runs. Second, during periods of difficulty of scoring runs, where the team score has changed from 54 runs with 2 batters out to 100 runs with 5 batters out, the strike rate has slowed to ~40. Here, video footage of this period in the match could be shown to the athlete with reflection upon several examples of correct anticipation in order to not attempt to strike the ball ("no action" known as a "leave" in cricket similar to a "check-swing" in baseball), which is equally important as the capability to anticipate in order to strike the ball to score runs (Müller et al., 2017).

A sport psychologist could reflect on the batter's strike-rate from a stress process perspective (Lazarus & Folkman, 1984). For example, the batter may have appraised the difficult situation in the game as benign, perhaps due to previous experiences in which they successfully managed difficult game situations. Consequently, the batter will be likely to utilize productive coping and emotional regulation strategies. This allows the batter to sustain their individual zone of optimal functioning in terms of anxiety and a range of other emotions (see Hagtvet & Hanin, 2007). Consequently, the batter is able to take, execute, and maintain the tactical game decision to adopt a low-risk game strategy by consciously lowering their strike-rate. Third, there is a period when the batter slightly increases strike rate to ~60, during the period of 118 runs with 5 batters out, until 192 runs with 8 batters out. Fourth, the batter decreases their strike rate to ~50 once again, then increases their strike rate towards 70, coinciding with them passing 100 runs, but also because there were only two batters remaining until the conclusion of the innings. There may be sustained periods of concentration through-out the innings, where the batter continues to take and execute tactical game decisions by adjusting their strike-rate to the situation in the game. This is indicative of a high ability to use coping and emotional regulatory resources to maintain within their individual optimal zones of functioning (Hagtvet & Hanin, 2007; Lazarus & Folkman, 1984). To this, intervention studies have shown that training programmes have been beneficial in providing athletes with the necessary skills to maintain their optimum zones of functioning (Robazza, Pellizzari, & Hanin, 2004), and facilitate athletes' performance (Cohen, Tenenbaum, & English, 2006). Therefore, a delicate interplay is apparent between accurate anticipation for action or inhibition of action in order to attack to score runs, as well as the batters' ability to maintain function within their optimum zone.

While using video footage in combination with the performance measures like runs scored to analyze an athlete's performance is valuable in discrete events in stadium-based sports, its value may be more limited in other circumstances. For example, it is technically difficult to use video to track each individual's performance during a continuous multi-player event such as a field hockey penalty corner. Wearables sensors are one solution that overcomes the limitations of traditional video-motion analysis such as missing footage from other players passing between the camera and the player of interest. Wearable tri-axial accelerometers have been used to examine the kinematics of elite specialist drag flickers during a penalty corner taken during simulated game play (Rosalie et al., 2018). Wearable sensors can also be used in sports where fixed cameras are incapable of capturing athlete kinematics, such as in motorsport. For example, wireless inertial motion units (IMUs) in combination with wireless electromyography has been used to examine the effect of changes in situation context on head movement for visual orientation during qualifying and when overtaking in open-cockpit Formula car racing (Rosalie & Malone, 2018a, 2018b). While the data from wearables is often only used to manage an athlete's training load, it clearly has an application in the design of an athlete's equipment (such as their vehicle), and designing training to improve performance (Rosalie, et al., 2018) or reduce errors (Rosalie & Malone, 2018a, 2018b).

Quantitative and Qualitative Assessment

The preceding sections have focused predominantly upon the use of quantitative data with some reflection. Recently, Vernon, Farrow and Reid (2018) used a qualitative approach to understand how professional tennis players use and integrate situational and kinematic information, to anticipate and return a serve in tennis. This approach allowed them to build a temporal model, which depicts the use of anticipatory information sources during the return of serve. This temporal model complements findings from quantitative work, which has reported the pick-up of contextual and kinematic information for anticipation with an action response in field-based settings (Morris-Binelli & Müller, 2017). Going forward, we believe that researchers could combine the strengths of qualitative and quantitative research methods to provide advanced insight into expertise and the learning process by utilizing a thoughtfully planned complementary mixed-methods approach (Gibson, 2016). Here, the mixed-methods approach can provide insight into how conscious thoughts and plans conflict with, or complement, the temporal pick-up of information to guide action. This can provide useful information of how to assess athletes' skills, and how to design training programs in terms of practice tasks, instruction and feedback to improve performance.

Representative Tasks to Assess and Train Athletes

A representative task can include perceptual, cognitive, motor and psychological components that reflect to a degree what is present in the competition setting (Araújo & Davids, 2015). Video- and spectacle-based temporal occlusion, as well as modified games or simulated sport-specific contexts, can be used to assess and train athletes because they represent visual information and motor responses from sport competition settings. To achieve this, it's critical that tests designed to assess or train athletes in, psycho-perceptual-motor skills reflect the competition setting.

In relation to a sport expertise perspective, for example, video simulation footage of a pitcher's kinematics and ball flight is representative of the visual information the batter views at the plate (Fadde, 2016). Such footage could be manipulated using video temporal occlusion as described earlier for the purposes of training anticipation. First, the performer (batter) is shown an occlusion trial (at the point of ball release in a pitcher's action) and anticipates pitch type. Second, a feedback trial is shown to the performer. The feedback trial is the same as the previous anticipation trial but is un-occluded to show the pitcher's action and all of the ball flight. This provides feedback to the prediction made by the performer on the occlusion trial. There is some evidence to indicate that training using video-temporal occlusion transfers to improved sports-specific motor skill performance in field-based settings (Fadde, 2016; Müller, Gurisik, Hecimovich, Harbaugh, & Vallence, 2017; Williams, Ward, Knowles, & Smeeton, 2002). Further work, however, is needed to confirm existing findings and explore new ways of consistently facilitating transfer of training improvements, particularly to competition.

Presenting video temporal occlusion training in conditions that mimic the anxiety that an athlete might experience during competition could facilitate transfer to competition. Recent evidence suggests that video temporal occlusion training administered under high anxiety conditions facilitated superior anticipation for experts both in video and field tests, when compared to training under low anxiety conditions (Alder, Ford, Causer, & Williams, 2016). Training interventions designed to improve psycho-perceptual-motor skill could also be administered using modified simulated games. For example, there is evidence that increasing the complexity and decreasing the familiarity of the situational context effects the orientation of the visual system for pick-up of visual information (Rosalie & Malone, 2018a; 2018b). Therefore, evidence exists to guide design of assessment and training tasks that represent competition settings to improve performance.

Recommendations for Practitioners

Several sports can better embed sport psychology and sport expertise knowledge to assess, and train athletes for higher levels of performance in competition. We propose the following recommendations. First, we recommend discussion of the importance of perceptual-cognitive-motor skills with athlete support staff within a high performance unit (see Steel et al., 2014 for skill acquisition). Second, we recommend explanation that these skills can be improved across emerging experts and well-established experts (e.g., see Alder et al., 2016; Bell, Hardy, & Beattie, 2013). Third, we propose that sporting organizations invest in a complete high-performance team consisting of a sport psychologist and skill acquisition specialist. Fourth, we support the investment in tools from sport psychology and sport expertise such as video temporal occlusion that have been previously reported to discriminate and improve psycho-perceptual-motor skill performance (Morris-Binelli & Müller, 2017). Until scientific evidence has demonstrated instruments such as virtual reality, Halo, stroboscopic glasses, Neurotracker and optometry-based visual training can discriminate and improve performance, we do not recommend using these techniques (e.g., see Williams & Jackson, 2019, regarding Neurotracker). Fifth, we encourage close collaborations between practitioners and scientists to design studies that investigate the mechanism(s) of performance, learning and transfer (see Morris-Binelli & Müller, 2017 for a model of anticipation and Rosalie & Müller, 2012, for a model of transfer). This will allow the practitioner to assess and train the mechanism(s) for higher levels of athletic performance. Finally, consider that psychological and expertise skills require specificity, progression, and overload over an extended period of time like fitness and strength in order to be improved (Farrow & Robertson, 2017). Accordingly, psycho-perceptual-motor skills can deteriorate if not continuously practiced. This indicates that equal proportions of time should be allocated to the practice of psycho-perceptual-motor skills during weekly training sessions. Some tools such as video temporal occlusion are portable and can be taken with a team during travel to competition.

Summary

Our aim in writing this paper was to highlight the immense potential of psycho-perceptual-motor skills to aid athlete assessment and training across a variety of sports. This can be achieved by sport psychology and sport expertise scientists, graduate students, and practitioners working closer together. We believe that such interdisciplinary collaboration will be highly beneficial to athlete training but can also reveal unique knowledge about the mechanisms that underpin expert performance in sports. Our research group (titled Sport Psychology and Sport Expertise) is already conducting studies that draw upon sport psychology and sport expertise knowledge to improve performance in field hockey goalkeeping and cricket batting. The research group continues to engage with practitioners from a variety of sports in our local area and overseas to disseminate new research findings and stimulate thought for future research.

Authors' Declarations

The authors declare that there are no personal or financial conflicts of interest regarding the research in this article.

The authors declare that they conducted the research reported in this article in accordance with the Ethical Principles of the Journal of Expertise.

References

Abernethy, B., Gill, D. P., Parks, S. L., & Packer, S. T. (2001). Expertise and the perception of kinematic and situational probability information. *Perception, 30*, 233-252. doi:10.1068/p2872

Abernethy, B., Kippers, V., Hanrahan, S. J., Pandy, M. G., McManus, A. M., & MacKinnon, L. (2013). *Biophysical foundations of human movement*. Champaign, IL: Human Kinetics.

Alder, D., Ford, P. R., Causer, J., & Williams, A. M. (2016). The effects of high- and low-anxiety training on the anticipation judgments of elite performers. *Journal of Sport and Exercise Psychology, 38*, 93-104. doi:10.1123/jsep.2015-0145

Araújo, D., & Davids, K. (2015). Towards a theoretically-driven model of correspondence between behaviours in one context to another: Implications for studying sport performance. *International Journal of Sport Psychology, 46*, 745-757. Retrieved from www.ijsp-online.com

Baker, J., Farrow, D., Elliott, B., & Anderson, J. (2009). The influence of processing time on expert anticipation. *International Journal of Sport Psychology, 40,* 476-488. Retrieved from www.ijsp-online.com

Bell, J. J., Hardy, L., & Beattie, S. (2013). Enhancing mental toughness and performance under pressure in elite young cricketers: A 2-year longitudinal intervention. *Sport, Exercise, and Performance Psychology, 2,* 281-297. doi:10.1037/a0033129

Causer, J., Smeeton, N. J., & Williams, A. M. (2017). Expertise differences in anticipatory judgements during a temporally and spatially occluded task. *PLoS One, 12*. doi:10.1371/journal.pone.0171330

Cohen, A. B., Tenenbaum, G., & English, R. W. (2006). Emotions and golf performance: An IZOF-based applied sport psychology case study. *Behavior Modification, 30*, 259-280. doi:10.1177/0145445503261174

Doo, W., & Kim, H. (2018). Modeling the probability of a batter/pitcher matchup event: A Bayesian approach. *PLoS One, 13*. doi:10.1371/journal.pone.0204874

Fadde, P. J. (2016). Instructional design for accelerated macrocognitive expertise in the baseball workplace. *Frontiers in Psychology, 7*. doi:10.3389/fpsyg.2016.00292

Farrow, D., & Robertson, S. (2017). Development of a skill acquisition periodisation framework for high-performance sport. *Sports Medicine, 47,* 1043-1054. doi:10.1007/s40279-016-0646-2

Farrow, D., Whiteside, D., & Reid, M. (2016). Exploring contextual information usage and anticipatory performance in elite tennis. *Journal of Sport & Exercise Psychology, 37,* S22-S23.

Fernandez-Echeverria, C., Mesquita, I., Conejero, M., & Moreno, M. P. (2019). Perceptions of elite volleyball players on the importance of match analysis during the training process. *International Journal of Performance Analysis in Sport, 19*, 49-64. doi:10.1080/24748668.2018.1559544

Gibson, K. (2016). Mixed methods research in sport and exercise: Integrating qualitative research. In B. Smith & A. C. Sparkes (Eds.), *Routledge handbook of qualitative research in sport and exercise* (pp. 382-396). Oxon: Routledge.

Gorman, A. D., Abernethy, B., & Farrow, D. (2011). Investigating the anticipatory nature of pattern perception in sport. *Memory and Cognition, 39*, 894-901. doi:10.3758/s13421-010-0067-7

Gray, R. (2002). Behavior of college baseball players in a virtual batting task. *Journal of Experimental Psychology: Human Perception and Performance, 28,* 1131-1148. doi:10.1037//0096-1523.28.5.1131

Hagtvet, K. A., & Hanin, Y. L. (2007). Consistency of performance-related emotions in elite athletes: Generalizability theory applied to the IZOF model. *Psychology of Sport and Exercise, 8*, 47-72. doi:10.1016/j.psychsport.2005.12.002

Johnston, K., Wattie, N., Schorer, J., & Baker, J. (2018). Talent identification in sport: A systematic review. *Sports Medicine, 48,* 97-109. doi:10.1007/s40279-017-0803-2

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping.* New York: Springer.

Morris-Binelli, K., & Müller, S. (2017). Advancements to the understanding of expert visual anticipation skill in striking sports. *Canadian Journal of Behavioural Science, 49*, 262-268. doi:10.1037/cbs0000079

Müller, S., Abernethy, B., Reece, J., Rose, M., Eid, M., McBean, R., . . . Abreu, C. (2009). An in-situ examination of the timing of information pick-up for interception by cricket batsmen of different skill levels. *Psychology of Sport and Exercise, 10*, 644-652. doi:10.1016/j.psychsport.2009.04.002

Müller, S., Fadde, P. J., & Harbaugh, A. G. (2017). Adaptability of expert visual anticipation in baseball batting. *Journal of Sports Sciences, 35*, 1682-1690. doi.org/10.1080/02640414.2016.1230225

Müller, S., Gurisik, Y., Hecimovich, M., Harbaugh, A. G., & Vallence, A. M. (2017). Individual differences in short-term anticipation training for high-speed interceptive skill. *Journal of Motor Learning and Development, 5*, 160-176. doi:https://doi.org/10.1123/jmld.2016-0029

Robazza, C., Pellizzari, M., & Hanin, Y. (2004). Emotion self-regulation and athletic performance: An application of the IZOF model. *Psychology of Sport & Exercise, 5,* 379-404. doi:10.1016/S1469-0292(03)00034-7

Rosalie, S. M., & Malone, J. M. (2018a). The effect of a halo-type structure on neck muscle activation of an open-cockpit race car driver training under qualifying conditions. *BMJ Case Reports*. doi:10.1136/bcr-2017-224013

Rosalie, S. M., & Malone, J. M. (2018b). Effect of halo-type frontal cockpit protection on overtaking. *BMJ Case Reports.* doi:10.1136/bcr-2018-225427

Rosalie, S. M., & Müller, S. (2012). A model for the transfer of perceptual-motor skill learning in human behaviors. *Research Quarterly for Exercise and Sport, 83*, 413-421.

Rosalie, S. M., & Müller, S. (2013). Timing of in situ visual information pick-up that differentiates expert and near-expert anticipation in a complex motor skill. *Quarterly Journal of Experimental Psychology, 66*, 1951-1962. doi:10.1080/17470218.2013.770044

Rosalie, S. M., Tang, W. I., McIntyre, A. S., Stockman, S., King, C., Watkins, C., . . . Ng, L. (2018). On using wearable tri-axial accelerometers to examine the striking phase kinematics of expert specialist drag flickers on-field. *Journal of Sports Sciences, 36*, 2455-2463. doi:10.1080/02640414.2018.1463630

Rumbold, J. L., Fletcher, D., & Daniels, K. (2012). A systematic review of stress management interventions with sport performers. *Sport, Exercise, and Performance Psychology, 1*, 173-193. doi:10.1037/a0026628

Runswick, O. R., Roca, A., Williams, A. M., Bezodis, N. E., & North, J. S. (2018). The effects of anxiety and situation-specific context on perceptual–motor skill: A multi-level investigation. *Psychological Research, 82*, 708-719. doi:10.1007/s00426-017-0856-8

Runswick, O. R., Roca, A., Williams, A. M., McRobert, A. P., & North, J. S. (2018a). The temporal integration of information during anticipation. *Psychology of Sport and Exercise, 37*, 100-108. doi:10.1016/j.psychsport.2018.05.001

Runswick, O. R., Roca, A., Williams, A. M., McRobert, A. P., & North, J. S. (2018b). Why do bad balls get wickets? The role of congruent and incongruent information in anticipation. *Journal of Sports Sciences*. doi:10.1080/02640414.2018.1514165

Steel, K., Harris, B., Baxter, D., King, M., & Ellam, E. (2014). Coaches, athletes, skill acquisition specialists: A case of misrecognition. *International Journal of Sports Science and Coaching, 9*, 367-378. doi:10.1260/1747-9541.9.2.367

Vernon, G., Farrow, D., & Reid, M. (2018). Returning serve in tennis: A qualitative examination of the interaction of anticipatory information sources used by professional tennis players. *Frontiers in Psychology, 9*, 1-11. doi:10.3389/fpsyg.2018.00895

Williams, A. M., Ford, P. R., Hodges, J., & Ward, P. (2018). Expertise in sport: Specificity, plasticity, and adaptability in high-performance athletes. In K. A. Ericsson, R. R. Hoffman, A. Kozbelt, & A. M. Williams (Eds.), *The Cambridge handbook of expertise and expert performance*. Cambridge, United Kingdom: Cambridge University Press.

Williams, A. M., & Jackson, R. C. (2019). Anticipation in sport: Fifty years on, what have we learned and what research still needs to be undertaken? *Psychology of Sport and Exercise.* doi:10.1016/j.psychsport.2018.11.014

Williams, A. M., Ward, P., Knowles, J. M., & Smeeton, N. J. (2002). Anticipation skill in a real-world task: Measurement, training, and transfer in tennis. *Journal of Experimental Psychology: Applied, 8*, 259-270.

Williams, M. A., Ward, J. D., Ward, P., & Smeeton, N. J. (2008). Domain specificity, task specificity, and expert performance. *Research Quarterly for Exercise and Sport, 79*, 428-433. doi:10.1080/02701367.2008.10599509

Woodman, T., Barlow, M., & Gorgulu, R. (2015). Don’t miss, don’t miss, d’oh! Performance when anxious suffers specifically where least desired. *The Sport Psychologist, 29*, 213-223. doi:10.1123/tsp.2014-0114

Zaichkowsky, L., & Peterson, D. (2018). *The play makers advantage: How to raise your mental game to the next level*. New York: Gallery/Jeter Publishing.

Received: 12 December 2018
Revision received: 21 March 2019
Accepted: 22 March 2019