

The use of video feedback as a facet of performance analysis: An integrative review

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Abstract

Video feedback is a well-established aspect of performance analysis (PA), employed to evaluate and describe performance. However, there is a lack of research investigating how video feedback used during PA can best support athlete learning and development. This integrative review sought to consider empirical evidence that has examined the effect of video feedback as a facet of PA on learning in sport settings. Following PRISMA guidelines, literature searches were conducted using PsycInfo, PubMed, Scopus, SPORTDiscus and Web of Science databases. Sixteen articles from an initial yield of 5,838 met the inclusion criteria. The analysis identified limited research settings and designs. PA delivery, e.g., coach-led classroom sessions or self-led practice, and the environment PA is provided in (e.g., dependence on classroom-type sessions) appear to influence learning, whilst scheduling of feedback appears to encourage the retention of declarative knowledge but may not transfer to performance. Collaborative practices between coach and athlete may enhance engagement and involvement in the learning process. The main conclusions highlight the need for greater variety in experimental methods in future PA research. Frameworks are required to build better understanding of effective PA delivery. This review was retrospectively registered with the Open Science Network (OSF) Registries (<https://osf.io/bqa6j>).

Keywords

Performance analysis, video feedback, skill acquisition, talent development

Introduction

Technological advancements in sport have changed the way that augmented information can be provided to performers (Maslovat & Franks, 2020). Research has reported perceived benefits in changing workflows within elite sport settings, with video and data forming integral parts to scientific support (Kidd, 2020). By way of example, video feedback in the form of performance analysis (PA) is widely adopted in applied sport as a feature of development and performance feedback processes (Wright et al., 2013). Research has highlighted how the field of PA has grown significantly in the last decade, with substantial advancements in technology and perceptions of sport practitioners and academics leading to the development of PA techniques, as well as an increase in the quantity of published research (Lord et al., 2020). In coaching contexts, PA and video feedback are adopted to provide information that can assist coach and player decision making (O'Donoghue, 2006). This is commonly in the form of objective information (e.g., so called, *key performance indicators*), proposed to gain insight and understanding into factors critical of performance (Wright et al., 2014, p. 714).

PA is suggested to enable the acquisition, evaluation, and presentation of information with the aim of improving sports performance (Sarmiento et al., 2014), with the athlete typically being the object and receiver of feedback, where the coach acts as the gatekeeper between the athlete and the feedback process (Bampouras et al, 2012). A key strength of PA is affording improved coach recall of events by providing highly accurate and comprehensive augmented feedback which is subsequently proposed to enhance decision-making (Jenkins et al., 2007; Nicholls & Worsfold, 2016). Research has also proposed the value of coaching through video feedback in identifying strengths and weaknesses of performance (Carson, 2008), informing change in behaviours (Cushion et al., 2012), and debriefing on performance (Macquet et al., 2015). However, despite research examining athlete and coach experiences of performance reviews via PA (Mackenzie & Cushion, 2013), little research has investigated how PA contributes to learning and development.

Debriefing is a practice that has been highlighted by coaches and athletes as an act that provides performance evaluation and learning opportunities (McArdle et al., 2010). This mirrors a similar process to that of PA, where the measurement of performance variables can be adopted with the aim of improving performance (Bartlett, 2001). It has been argued that, presently, there is a lack of research devoted to understanding the workings and dynamics of

PA as a form of feedback and as an evaluative tool, with research focused on trying to describe and predict performance variables (Mackenzie & Carling, 2013). A pertinent consideration is that PA commonly involves the provision of augmented feedback that consists of the coding (or counting) of events and performance variables. Thus, PA could be defined as a practice which requires a deliberate coding process to produce performance information. Debriefing, on the other hand, is commonly conceptualised as a practice that is provided without a deliberate coding structure, can occur in different environments (e.g., within the performance environment or in a formal capacity away from performance), and in an immediate or delayed manner with or without additional resources (e.g., video and statistics) (McArdle et al., 2010).

Whilst both PA and debriefing have been presented as practices to impact athlete learning, the variables captured in PA have been suggested to be more numerous because of their availability as an outcome of a coding structure, which may not necessarily result in a more comprehensive understanding on performance, and as such, the influence of PA on athlete learning is often neglected (Mackenzie & Carling, 2013). Whilst the coding of performance variables appears to represent a defining hallmark of the PA process, consideration of complementary feedback literature indicates that how information is relayed to the learner is critical to its effect (Petancevski et al., 2022). Literature suggests that there is a didactic nature to how this information is typically presented in practice (McArdle et al., 2010), with coach perceptions purportedly resulting in behaviours that overly control athlete learning (McCosker et al., 2021). Therefore, consideration of pedagogical approaches and interactions used by a coach in feedback practices is a key consideration (Groom & Nelson, 2013) for the enhancement of how PA is used to positively impact on learning.

Augmented feedback itself can be defined as information regarding performance that supplements intrinsic feedback and is provided by an external source (Anderson et al., 2019). The adoption of video within this process has been perceived to enhance learning opportunities through observation and imitation (Liebermann et al., 2019). In an applied sporting context, feedback commonly follows coach observations, and has been categorised as contributing towards one or more of the four following themes: (i) improving performance; (ii) monitoring progress; (iii) helping coaches to improve; and (iv) building athlete confidence (Mason et al., 2020b). However, the delivery of augmented feedback is complicated by a variety of factors. For example, research investigating the event recall abilities of experienced coaches indicates that only 59.2% of critical match events are

accurately recalled (Laird & Waters, 2008). Moreover, feedback provided with the use of video has highlighted similar results, with athletes recalling only 50% of (on average) 30 messages provided by coaches in video feedback meetings, and only 6% of all feedback a week later (Mason et al., 2021). PA itself may facilitate these difficulties, where observation and analysis of aspects of performance can inform training design and implemented to influence competition or match performance (Franks & Hughes, 2016; O'Donoghue, 2006).

The application of video feedback is apparent in training programmes aimed at developing tactical knowledge of athletes (García-González et al., 2013). Studies have combined the review of video clips with questioning, primarily using three stages (e.g., Moreno et al., 2008): (i) review of video by an expert that is not the performer, in relation to contextual information (e.g., score line); (ii) self-analysis and reflection by the performer; and (iii) combined analysis by the expert and performer of the causes and reasons for the decisions. This method has been shown to improve declarative tactical knowledge and decision-making of tennis players (e.g., García-González, et al., 2014) and volleyball players (e.g., Gil-Arias et al., 2015). Specifically, it has been proposed that the three-stage approach of Moreno et al. (2008) may facilitate the creation of more advanced procedural knowledge structures that subsequently enable better performance execution. Whilst this body of research identifies the possible benefits of video feedback in enhancing sports performance, there is a lack of empirical work in the use of PA as a feature of training interventions (McRobert & Williams, 2019), where research has not specifically considered the role of PA in the learning process.

The adoption of PA and video feedback methods in applied practice has been substantial, facilitated by advancements in technology and the perceived need to utilise PA within sport performance environments (Williams & Manley, 2016). However, in PA settings, greater understanding is required to enable feedback to be effective in enhancing learning (Mason et al., 2020a), particularly when feedback is provided through video (Mason et al., 2020b). Research has highlighted discrepancies in the views of analysts and coaches regarding the use of PA in applied practice (Nicholls et al., 2022). Moreover, whilst it has been suggested that the objective of PA is to create learning opportunities (Martin et al., 2021), knowledge on the effects of video feedback and PA is relatively limited (McRobert & Williams, 2019). Moreover, there is current scrutiny regarding the potential benefit to self-regulation and autonomy when video, self-controlled feedback, and observation are used (McKay et al., 2022a), with such studies also primarily confined to laboratory settings (Ste-

Marie et al., 2020). The examination of PA in applied settings would therefore offer a novel perspective in the feedback literature and widen current understanding of the potential benefits of video feedback and PA. With this in mind, the aim of this integrative review is to critically consider empirical evidence on the effect of video feedback as a facet of PA on learning in applied sport settings. To develop understanding on how learning is facilitated, the review will focus on the literature examining video feedback and PA, specifically considering the delivery, feedback environment, scheduling, and collaboration between coach(es) and athlete(s).

Method

Systematic reviews are used to appraise and synthesise a body of literature following a dedicated search process (Grant & Booth, 2009), and have been highlighted as being widely adopted in sport and exercise psychology research (Gunnell et al., 2021). By way of an extension in methodology, an integrative review enables a wider discussion of phenomena to occur, with scope to include a diverse body of research to be reviewed, including empirical, methodological, and experimental literature (Toronto & Remington, 2020). An integrative review therefore enables the integration of experimental (e.g., Herold et al., 2022) and non-experimental (e.g., Groom et al., 2011) literature in the analysis, permitting a broader critical appraisal of research through the inclusion of quantitative and qualitative methods (Whittemore & Knafl, 2005). This form of review is well adopted within clinical settings (Toronto & Remington, 2020) but is currently in its infancy in sports science literature (for an example, see e Pina et al., 2018). Specific to the aims of the current research, following perspectives emphasised elsewhere (Torraco, 2005), an integrative review method was deemed most suitable to allow the results of this review to identify the current state of knowledge and highlight future areas of enquiry.

Search strategies

The search strategy for this integrative review followed PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidelines (Page et al., 2021). This process, summarised in Figure 1 in the Results section, involved a search strategy using keywords, followed by screening for appropriate studies, resulting in exclusion of non-

relevant studies and duplicates. An assessment of eligibility and quality was used to finalise the yield of analysed studies. Electronic databases (PsycInfo, PubMed, Scopus, SPORTDiscus and Web of Science) were used to search for articles, with no defined timespan of publication date. The last search was completed on 15th November 2021. Other databases were omitted from use (e.g., Google Scholar), as the search returned too broad a spectrum of results. Searches were conducted using Boolean phrasing of keywords that were related to the aim of the review. Therefore, the search phrase used in each of the five databases was “Sports” AND “Performance Analysis” AND “Learning. The search results within each database were filtered to only include articles published in academic journals in English.

Inclusion and exclusion of studies

Two of the authors (AP and MD) assessed the studies separately to determine their eligibility for inclusion. Studies deemed suitable for inclusion adhered to two main principles: (1) the study was focused on PA; specifically, the study took place in an applied sports performance setting clearly using PA and was representative of the PA process outlined in the introduction, that is, a deliberate coding process is employed to produce performance information; and (2) the study had a focus on video feedback. By way of example, van Maarseveen et al. (2018) compared the effect of self-controlled video feedback compared to a yoked group on tactical skills in small-sided football games, with self-controlled video feedback was identified to confirm correct and incorrect aspects of performance and influence involvement in the learning process. For inclusion, the focus of the study also needed to be oriented towards learning with an applied sports population. Studies were excluded if: (1) content was not related to PA; (2) not specific to a sporting population or context (for example, physical education); (3) the study focused on biomechanics, sports rehabilitation, physiology, strength and conditioning, medicine, or modelling techniques in observational learning; (4) video feedback was not a feature of the study; (5) the study was in the form of a literature review; and (6) the study was published in a language that was not English.

Screening and management of articles

The results from each search were exported as a comma-separated values (CSV) file, all of which were combined in Microsoft Excel to create a workbook. This enabled values at each stage of the PRISMA process to be calculated. The initial database search returned a total of 5,838 articles. Firstly, duplicates were removed by sorting article titles into alphabetical descending order in Microsoft Excel. The remaining articles were moved to a new sheet within the Excel workbook, and review of the remaining studies (N = 4,624) was conducted to examine the relevance of each article title for the aim of the review. Articles with titles that were deemed of interest were moved to a separate sheet (N = 26), before assessment of the abstract and keywords of each article was conducted by each author. The authors wish to acknowledge this is a notable reduction in articles. However, the search databases returned large numbers of research that were clearly unrelated to this integrative review based on the title alone. Whilst in a different research area, drastic literature reductions are present in other literature review (please see Lindsay et al., 2021). Whilst in a different research area, namely mental imagery interventions in sport, Lindsay et al. (2021) comparably reduced an initial article yield of 5,031 articles (3,162 after duplicate removal) to 36 following screening for inclusion in their systematic review and meta-analysis. In occurrences of uncertainty over article suitability, comparison was made between papers to assess similarities between them. If an abstract did not provide sufficient detail for the selection decision, full-text examinations (N = 16) were performed. Finally, reference lists of the articles that were deemed to meet the inclusion criteria were screened to identify any further appropriate articles.

Generation of themes

To identify potential patterns within the existing literature, an inductive, thematic process was adopted to generate themes. The approach reflected the six-phase process of Braun and Clark (2021), comprising familiarisation of the data, initial coding, identifying patterns, review of themes, defining and finalising themes, and presentation of the themes. As this was an active process, discussions and critical debate were held between members of the research team under the guise of critical friends to help form the final structure of the themes (Berends & Johnston, 2005).

Quality assessment

The articles that met the inclusion criteria were considered in context of the aims of the study and subject of this review, in line with extant literature published in IRSEP (e.g., Fardilha & Allen, 2020). Thus, the quality of each article was considered in relation to whether learning was a key aspect of the research, in relation to video feedback being a facet of PA. Being an integrative review, both qualitative and quantitative research were considered, enabling the critical appraisal of a more diverse range of methodologies and associated findings (Whittemore & Knafl, 2005). To the best of the authors' knowledge, this is the first review to examine the learning effects of video feedback provided through PA, and with that in mind, it was important to adopt a methodology that incorporated a wider body of research for synthesis and discussion to enhance the quality and rigour of the review.

Results

Following full-text reviews, and consideration of the study aim along with the inclusion and exclusion criteria, a total of sixteen articles were identified. The full-text review of the articles are presented in Table 1, highlighting key aspects of the research which is expanded upon in the following subheadings with four distinct themes regarding practice design being identified from the "Findings" column. These themes were derived from discussion within the research team, where it was apparent that the reviewed literature highlighted these areas as being critical to effective PA processes. The themes discussed are: (1) Delivery of PA and consideration for the implications this might have on learning (e.g., Raya-Castellano et al., 2020); (2) the environment PA is conducted in might aid learning further (e.g., Brümmer, 2018); (3) scheduling of PA was highlighted to encourage learning opportunities (e.g., Francis & Jones, 2014); and (4) collaborative practices may further enhance positive experiences and engagement when receiving PA (e.g., Groom et al., 2011).

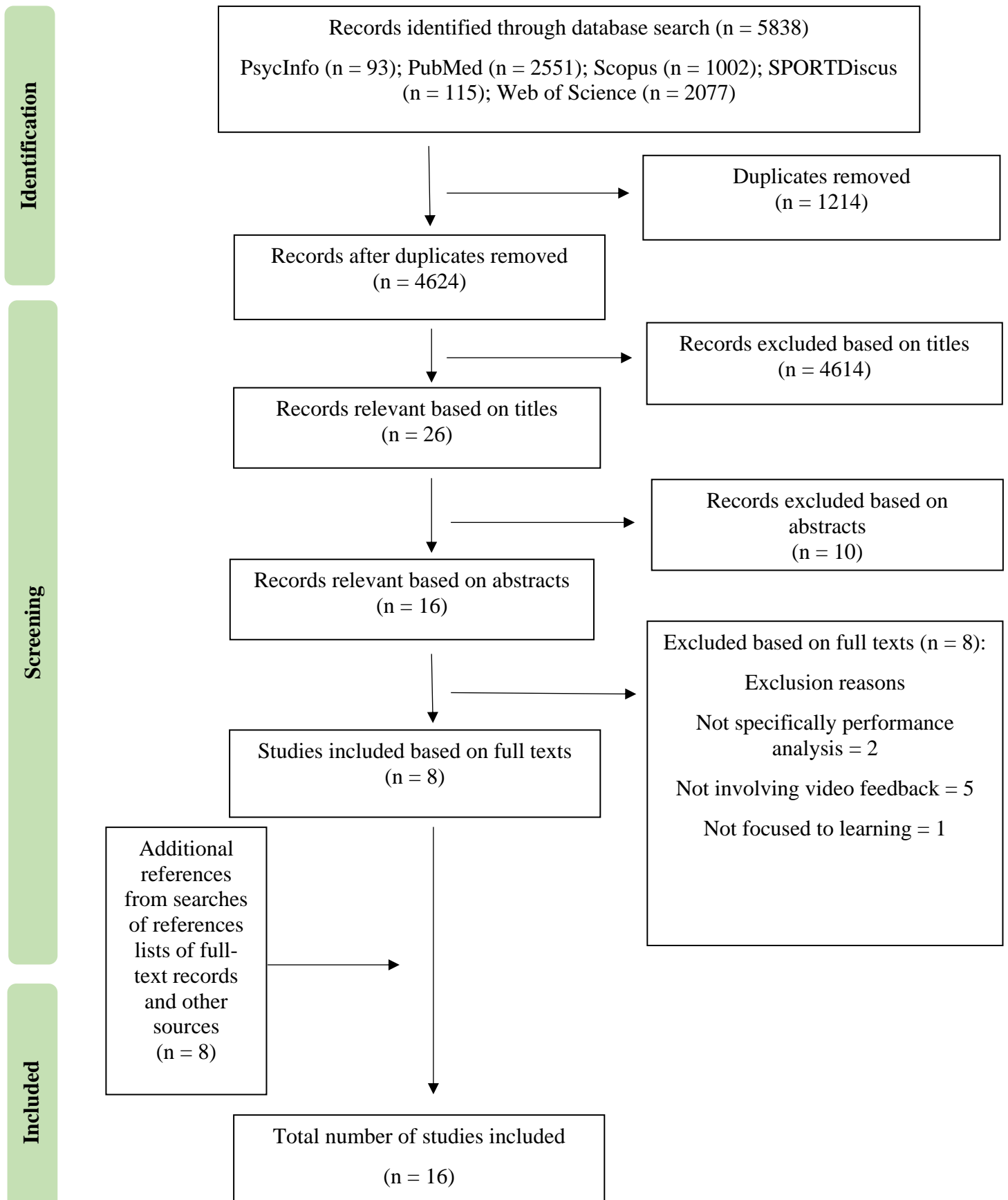


Figure 1. PRISMA flow chart diagram.

Sports and setting studied

The most prevalent sport investigated was soccer (N = 11), followed by rugby union (N = 2). Other studies covered ice hockey (N = 1), rugby union and field hockey (N = 1), and water polo and netball (N = 1). Professional youth soccer academies (N = 7) were the most prominent setting studied (Booroff et al., 2016; Brümmer, 2018; Groom & Cushion, 2005; Groom et al., 2012; Partington et al., 2015; Raya-Castellano et al., 2020; Wright et al., 2016). Two articles were in a national youth soccer context (Groom et al., 2011; van Maarsaveen et al., 2018), and one study examined soccer academies from both professional clubs and national youth teams (Middlemas & Harwood, 2018). Outside of soccer, two articles were in a professional rugby union environment (Francis & Jones, 2014; Middlemas et al., 2018) and there were single articles in elite level ice hockey – specifically a player case study – (Nelson et al., 2014), professional senior level football (Herold et al., 2022), youth, school and national amateur rugby union and field hockey (Vinson et al., 2017), and elite national standard netball and water polo (Loo et al., 2020). The research was set in a limited spread of nations, with those being England/Great Britain/United Kingdom (N = 11), Germany (N = 1), New Zealand (N = 1), The Netherlands (N = 1), Singapore (N = 1), and the United States of America (N = 1).

Research methods adopted

Qualitative methods were used in fourteen of the sixteen studies. The most common method (N = 5) encompassed semi-structured interviews (Booroff et al., 2016; Groom et al., 2011; Middlemas & Harwood, 2018; Nelson et al., 2014; Vinson et al., 2017). Five articles adopted semi-structured interviews in combination with video observations and debrief sessions (Brümmer, 2018; Groom et al., 2012; Middlemas et al., 2018; Partington et al., 2015; Raya-Castellano et al., 2020). Three articles used a questionnaire and semi-structured interviews (Francis & Jones, 2014; Loo et al., 2020; Wright et al., 2016). One article utilised a semi-structured questionnaire (Groom & Cushion, 2005), and two articles adopted an intervention approach in the effectiveness of video feedback on player passing (Herold et al., 2022) and in the analysis of tactical training (van Maarseveen et al., 2018).

Practice design: Delivery

Video was suggested to act as a tool to create opportunities for discussion and perceived to facilitate learning (e.g., Groom & Cushion, 2005), enabling athletes to recognise and articulate knowledge (Partington et al., 2015), and resulting in general improvements in performance based on numerical increases in traditional KPI's (Herold et al., 2022). Studies suggested that video facilitated a mutual understanding between the coach and athlete (Brümmer, 2018; Groom et al., 2011), with objective information changing initial perceptions of performance (Groom & Cushion, 2005). Studies highlighted that providing feedback through examples linked to athlete learning objectives (Raya-Castellano et al., 2020) was an important feature of successful PA.

Practice design: Environment

Studies highlighted that the preferred environment for PA delivery was away from “classroom” settings (e.g., Loo et al., 2020). Accessibility of footage was deemed essential (e.g., Francis & Jones, 2014), which should cater for individual preferences (Brümmer, 2018). Video feedback alone may not enhance knowledge and understanding (Nelson et al., 2014), and inconsistency in provision may hinder the transfer of learning to on-field performance (Middlemas et al., 2018). Learning through PA could be enhanced by promoting player involvement (Raya-Castellano et al., 2020), with collaborative practices between coach and athlete providing greater opportunities for discussion (e.g., Vinson et al., 2017). To this end, it appeared to be beneficial to restructure feedback sessions (Loo et al., 2020), so that PA is more than coaches and athletes receiving information (Vinson et al., 2017).

Practice design: Scheduling

Similar learning opportunities were possible from PA feedback sessions that take place pre- and post-competition and training (Loo et al., 2020). One study suggested that immediate feedback (e.g., during an activity or training) may allow for learning opportunities to occur in context (Francis & Jones, 2014), whilst changes in performance might be due to players prioritising certain actions presented in the video feedback (Herold et al., 2022). Considering the importance of self-regulation, feedback preferences should be considered (Vinson et al., 2017) to enhance learning, with some indications that shorter sessions (i.e., 11-20 minutes) designed as open forums (Wright et al., 2016), focusing on feedback after good

performances (van Maarseveen et al., 2018) may be most beneficial. Findings also suggested that the manipulation of PA by a coach may have a negative impact on the PA process (Booroff et al., 2016).

Practice design: Collaboration

Enabling athletes to control feedback had a positive effect by satisfying autonomy (e.g., Middlemas & Harwood, 2018;). Autonomy-supportive environments were provided by allowing players to lead team debriefs (Middlemas et al., 2018), but this may not be preferred by all individuals (Vinson et al., 2017) possibly due to the fact that individual differences were found to affect multiple aspects of the analysis-feedback process (Brümmer, 2018). The hierarchical nature of debrief sessions impacted on learning (Groom et al., 2012), which was also suggested to cause conflict between athlete autonomy, and coach knowledge and beliefs (Partington et al., 2015). Negative experiences when receiving PA have a potentially adverse effect on athlete learning (Groom et al., 2011) and this may be due to the fact that some coaches were unable to clarify why they engage in certain pedagogical approaches (Raya-Castellano et al., 2020). Coach involvement in the feedback process might be a significant contributing factor to transfer into performance (Herold et al., 2022).

Table 1. Summary of studies examining video feedback during PA that were included in the integrative review.

Author (Date)	Sport	Participants	Setting	Nation	Aim	Method	Findings
Booroff et al. (2016)	Soccer	Coach	Professional academy	England	Examine how a coach used video-based technologies to fulfil the expectations of his role	Semi-structured interviews and video observations	<p>Video-based feedback was manipulated by the coach.</p> <p>Video-based feedback is not a straightforward process in enhancing athlete learning.</p> <p>Gifted athletes received more video-based feedback to maximise opportunities of becoming professional.</p>
Brümmer (2018)	Soccer	Coaches and players	Professional academy	Germany	Examine effects of technology on PA and training procedures	Observations and interviews exploring video analysis practices and its apparent effects	<p>Coach-led video analysis used to describe events.</p> <p>Coach knowledge of player understanding can be used to prescribe training measures.</p> <p>Access to footage enables self-organisation.</p>

							Feedback through video provides assumes a certain level of tactical understanding in players.
Francis & Jones (2014)	Rugby Union	Players	Professional club	Great Britain	Perceptions on use of PA to improve performance	Semi-structured questionnaire and interviews	<p>Video is a learning tool, enabling players to observe areas of improvement.</p> <p>Immediate feedback viewed positively for learning in training.</p> <p>Quantity of information in delayed feedback perceived to be too great.</p> <p>Relevance of information for match preparation crucial to learning.</p> <p>Accessible footage critical for player learning opportunities.</p>
Groom & Cushion (2005)	Soccer	Players	Professional academy	England	Player perceptions on PA in their development programme	Semi-structured questionnaire	<p>Video and practical training sessions preferred learning method.</p> <p>Classroom sessions viewed least favourably.</p>

							Video sessions enhanced player learning, focusing on strengths and weaknesses, game understanding, and decision-making.
Groom et al. (2011)	Soccer	Youth coaches	National teams	England	Develop a theoretical framework to understand the delivery of PA by coaches	Semi-structured interviews	PA viewed as a teaching tool to facilitate learning. Negative experiences of players in receiving PA highlighted. PA can create mutual understanding between coach and athlete.
Groom et al. (2012)	Soccer	Youth coach	Professional academy	England	Examine pedagogical interactions between coach and players during team-based PA	Observational analysis	Hierarchical debrief sessions, when led by a coach, impact negatively on athlete interactions. Coaches should consider how their beliefs and behaviours impact on athletes.
Herold et al. (2022)	Soccer	Players	Professional club	United States of America	Examining effectiveness of a video feedback intervention on	Intervention pilot study	Video intervention resulted in general improvements in performance.

					player passing metrics		<p>Players in Intervention Team might have prioritised certain actions based on what was presented in video.</p> <p>Limited transfer into performance might be due to lack of coach involvement in feedback process.</p>
Loo et al. (2020)	Water Polo and Netball	Coaches and players	Elite teams	Singapore	Develop understanding on the use of PA in women's sport from athlete and coach perspectives	Semi-structured online questionnaire and interviews	<p>Similar learning opportunities during training and competition phases in feedback sessions pre- or post-performance.</p> <p>Classroom settings were viewed least favourably and counterproductive.</p> <p>Education on how to use the PA process effectively required.</p> <p>Effective relationships, collaborative learning and open discussions needed to maximise learning.</p>
Middlemas et al. (2018)	Rugby Union	Team	Professional team	New Zealand	Investigate the impact of debriefing and previewing on	Observational analysis and semi-	Difficulty converting learning from meetings into performance, complicated by inconsistent debriefing process.

					professional rugby team performance	structured interviews	<p>Players provided autonomy in guiding their own learning, but lack of engagement.</p> <p>Consideration of preferences in receiving feedback and how to access feedback can aid honest player reflection.</p>
Middlemas & Harwood (2018)	Soccer	Coaches and players	Professional academy and youth international	England	Examine psychological factors influencing PA delivery through player and coach perceptions	Semi-structured interviews	<p>Learning through PA maximised by one-to-one and private meetings.</p> <p>Encouraging players to take greater control of their own learning viewed positively.</p> <p>Scenarios where players do not need the coach allows self-regulation.</p> <p>Need to balance positive and negative feedback in creating supportive learning environments.</p>
Nelson et al. (2014)	Ice Hockey	Player	Elite player	England	Insight into how the player responded to coach delivery	Reflexive, semi-	PA alone not seen to enhance athlete knowledge and understanding.

					of video-based feedback	structured interviews	<p>Teammate contributions to learning an important factor.</p> <p>Different approaches to PA required to shape engagement.</p> <p>Coach-athlete relationship may determine PA effectiveness, along with content of sessions.</p>
Partington et al. (2015)	Soccer	Youth coaches	Professional academy	England	Longitudinal approach to gain understanding on how video-based feedback can inform coaches' reflective practice	Observational analysis and semi-structured interviews	<p>Video helped coach learning, analyse their behaviours, support reflection, and enable discussion.</p> <p>The knowledge, experience, and beliefs that a coach has developed may conflict with autonomy.</p>
Raya-Castellano et al. (2020)	Soccer	Youth coaches	Professional academy	England	Explore the behaviours of coaches during team-based video-feedback	Observational analysis and semi-structured interviews	Player knowledge constructed by requiring them to find video examples that link to individual learning objectives.

					sessions and underpinning pedagogic principles		Coaches unable to rationalise why they engaged in certain pedagogical approaches. Player involvement to engage learning should be promoted.
van Maarseveen et al. (2018)	Soccer	Youth players	National team	The Netherlands	Assess self-controlled feedback in tactical training sessions	Intervention study	Feedback requested mostly after good trials. Feedback was used to confirm success or correct errors. Conversations between coach and players covered positive and negative aspects of performance. Controlling video had a positive effect on the involvement of players in the learning process, satisfying autonomy and promoting self-regulation.
Vinson et al. (2017)	Rugby Union and	Head and assistant coaches, and players	National and regional senior amateur standard, and	United Kingdom	Examine the use, factors, and perceptions of using an online	Semi-structured individual and	Inclusive approach to PA and the subsequent learning process was provided

	Field Hockey		youth club and school level		video coaching platform	group interviews	<p>Autonomy-supportive processes not preferred by all individuals</p> <p>Association between collaborative learning, including peer learning and mentoring, creates a positive team culture.</p>
Wright et al. (2016)	Soccer	Youth players	Professional academies	England	Explore the preferred engagement of players with PA	Online questionnaire and semi-structured interviews	<p>Shorter feedback sessions preferred, but this was associated with what the players were used to.</p> <p>Open forums noted as beneficial to engagement, increasing the retention and transfer of learning.</p> <p>Individual and smaller group feedback might enhance learning.</p> <p>Reviewing of video in their own time was noted to create a more positive learning environment.</p>

Discussion

The aim of this integrative review was to critically consider extant research that has examined the effect of video feedback as a facet of PA in sport. The results revealed the following themes: (i) youth soccer is the most prevalent sport and setting (e.g., Groom et al., 2011, 2012); (ii) fourteen of the sixteen articles used qualitative methods, with two articles adopting a quantitative, intervention approach (Herold et al., 2022; van Maarseveen et al., 2018); (iii) the manner of delivery of PA might play a pivotal role in supporting athlete learning (e.g., Raya-Castellano et al., 2020); (iv) the environment in which PA is conducted appears to be critical to its effectiveness (e.g., Loo et al., 2020); (v) the scheduling of when information is provided via PA appears to influence the retention of declarative knowledge, but not necessarily transfer to on-field performance (e.g., Middlemas et al., 2018); and (vi) collaborative processes between coach and athletes may aid engagement and involvement in the learning process (e.g., van Maarseveen et al., 2018). Importantly, extant PA research is limited, with studies primarily adopting cross-sectional designs that examine retrospective perceptions on the impact of learning. An infographic is presented in Figure 2 to highlight the key aspects of the review.

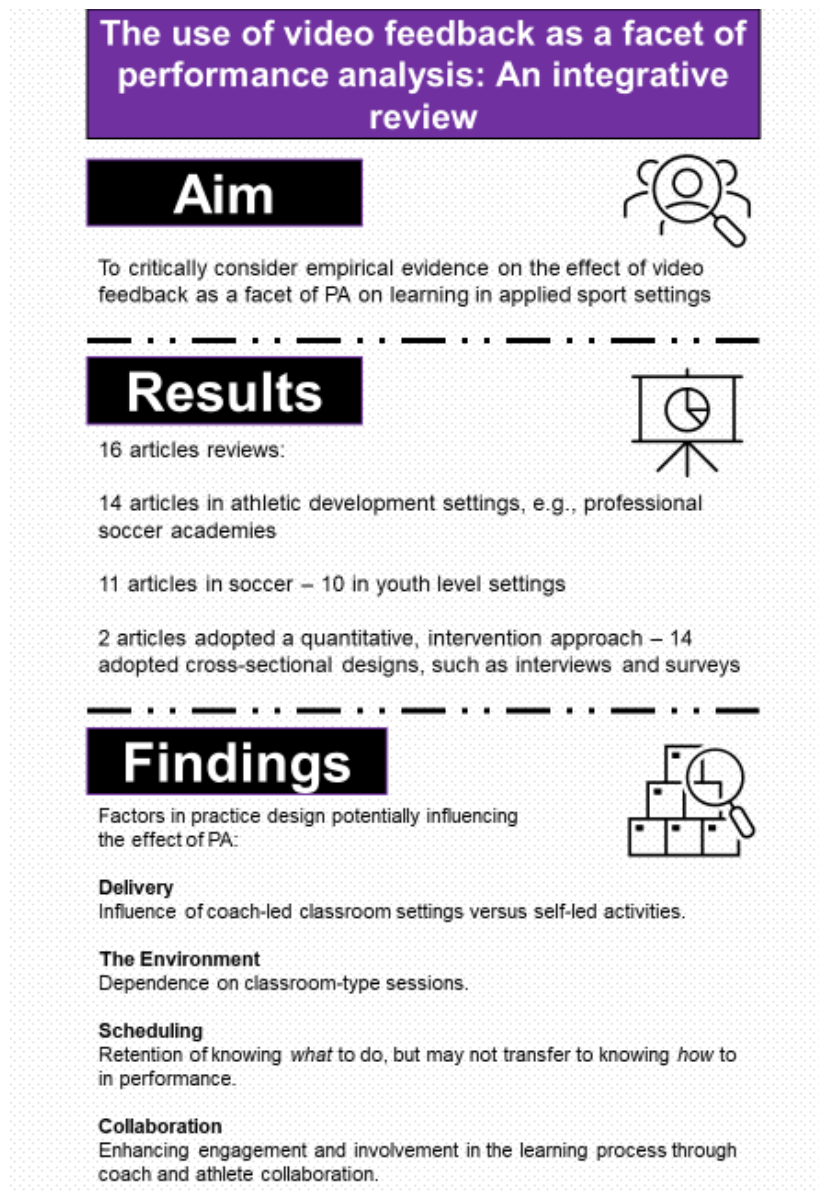


Figure 2. Infographic presenting key aspects and findings of the review.

The results from this review have identified that soccer is the most studied sport, representing eleven of the sixteen articles that met the inclusion criteria (e.g., Groom et al. 2011). Furthermore, the fourteen articles used a participant sample applicable to an athletic development setting, be it coaches (e.g., Partington et al., 2015), athletes (e.g., Wright et al., 2016), or coaches and athletes (e.g., Loo et al., 2020), or a team (Middlemas et al., 2018). All but one of the articles set within soccer, along with a single article investigating youth and amateur rugby union and field hockey (Vinson et al., 2017), were applied to youth level. Thus, only five articles investigated video feedback and PA in adult sport; two in rugby union

(Francis & Jones, 2014; Middlemas et al., 2018), one in football (Herold et al., 2022), one in ice hockey (Nelson et al., 2014), and one in netball and water polo (Loo et al., 2020). Furthermore, the results reflect those of previous talent research with a lack of representation in wider socio-cultural populations being apparent (Baker et al., 2020), with only six nations reflecting the limited geographical spread of the evidence base. This highlights a limited perspective on any effects that PA might have on learning and performance, where current research has been constrained to a small pool of sports and nations, likely resulting in a narrow account of different coaching, social, and cultural factors (Rothwell et al., 2019). Only one of the sixteen articles is based in a non-ball-based sport (ice hockey), as such further research in additional sports would be of benefit to expand on current understand of PA processes and enhancing effective practice. Perhaps most significantly, only two articles adopted an intervention in order to assess the effect of video feedback on learning (Herold et al., 2022; van Maarseveen et al., 2018). It would be incorrect to assume that learning occurs just because feedback is being provided through PA, and as such, future research would therefore benefit from the adoption of a broader range of experimental methods (see Meredith et al., 2018) in order to adequately examine the impact of different video-based PA interventions on athlete learning and performance. Indeed, it is essential that future work is framed in consideration of questions raised by current research on the quality of evidence in the wider feedback literature (McKay et al., 2022a), especially where PA is perceived as a critical component of the feedback process.

The studies reviewed indicated that the use of PA was perceived as a tool that facilitates learning (Groom et al., 2011), enabling identification of strengths and weaknesses in athlete performance (Groom & Cushion, 2005), and areas for improvement (Francis & Jones, 2014). Video acted as a tool to create opportunities for discussion (Partington et al., 2015), whilst relevance of information (feedback) appears crucial in aiding the storing of information and transfer into future recall (Francis & Jones, 2014). Elferink-Gemser et al. (2010) discussed the development of declarative and procedural knowledge in youth field hockey players, where both sub-elite and elite players had well developed knowledge *about* aspects such as game rules and ball actions, but elite players were better at interpreting *how* to coordinate actions in game situations. When combining video with coach analysis, Moreno et al. (2008) reported that procedural knowledge was enhanced in international level volleyball players, where the participants became more selective and consistent with their actions in performance. Previous research has highlighted that training and playing team

sports, such as soccer, facilitates the transition from declarative to procedural knowledge more effectively than observation alone (Williams & Davids, 1995). Furthermore, qualitative feedback through the coach might better facilitate transfer into performance in creating open forum dialogue and not relying solely on players' own knowledge (Herold et al., 2022). Indeed, whilst findings from Elferink-Gemser et al. (2010) indicate that declarative knowledge might be the same between sub-elite and elite performers, procedural knowledge better reflects higher level performers (Gil et al., 2012). Future research would benefit from examining the role of video feedback via PA in developing procedural knowledge, evaluated through appropriate transfer tests and longitudinal interventions (Pocock et al., 2019), particularly in combining on-field practice methods alongside video feedback.

The most preferential learning environment for PA delivery appears to be away from formal classroom settings (Groom & Cushion, 2005; Loo et al., 2020). The delivery of PA being in a classroom setting may be linked to embedded sociocultural processes (Vinson et al., 2017) or that coaches may not understand why they adopt a certain approach to PA, potentially hindering the feedback environment (Raya-Castellano et al., 2020). Middlemas et al. (2018) reported that autonomy-supportive environments can be provided by allowing players to lead team debriefs, use questioning, and open one-to-one sessions. However, such autonomy-led interventions may not be preferred by all individuals, so it is imperative to consider how information is communicated to inspire a cohesive learning environment (Vinson et al., 2017). In addition, video might cause conflict between the knowledge, experience, or beliefs that a coach has concerning an athlete's performance (Partington et al., 2015). Such conflict may be linked to the coach's recall ability, where experienced coaches are more able to identify what reflects a critical performance event (Laird & Waters, 2008). Player views might also conflict with those of the coach, which in turn might delegitimise perspectives a player might possess (Brümmer, 2018), alluding to hierarchical environments that limit player or athlete autonomy. Development of frameworks to aid in increasing coach knowledge and understanding of delivering PA may aid in connecting desired and actual behaviours (Raya-Castellano et al., 2021).

Evidence indicated that a coach may demonstrate motivation to prioritise specific individuals, (e.g., those of higher ability), at the expense of enhancing the PA process for all (Booroff et al., 2016). Negative experiences when receiving PA was noted as having a potentially adverse effect on athlete learning (Groom et al., 2011). Furthermore, enabling self-regulated activities, balancing positive and negative feedback with peer-to-peer

interaction in a supportive learning environment, may help overcome fears and negative perceptions (Middlemas & Harwood, 2018). Thus, creating an environment more conducive for effective learning through feedback on an individual or small group basis, might be most beneficial (Vinson et al., 2017), particularly if sessions are shorter, and there is open dialogue (Wright et al., 2016). Enhancing learning from PA appears to be stimulated by promoting player involvement (Raya-Castellano et al., 2020), with the collaborative role of teammates providing greater opportunities to engage in discussion (Nelson et al., 2014; Vinson et al., 2017). The coach-athlete relationship is a further factor to consider, both in terms of content and delivery (Nelson et al., 2014). The coach in Booroff et al. (2016) manipulated their use of PA to assist fulfilment of their perceived role. However, the approach resulted in feedback as a hierarchical, prescriptive, and authoritarian process led by a coach limiting the opportunity for the athletes to experience autonomy and self-regulation (Groom et al., 2012). In contrast, Gleeson and Kelly (2021) suggested that the reduction of potential threats and pressures can enhance the social PA environment, enabling opportunities to engage in self-regulated learning. Examining the effect of such environments, perhaps more specifically peer-to-peer video feedback during PA, could prove informative for future research.

Accessibility of footage and identification of how to maximise learning through video feedback were deemed essential factors for the creation of effective PA (Francis & Jones, 2014; Middlemas & Harwood, 2018), which should aid athlete reflection (Middlemas et al., 2018). Similar learning opportunities were noted to occur in feedback sessions, both pre- and post-competition, and training (Loo et al., 2020). Francis and Jones (2014) identified that immediate feedback may allow for learning opportunities to occur in training, which might be easier to implement to see an immediate change in performance. Crucially, the timing of feedback should be considered in relation to athlete motivation, as the individual might already sense how well they performed, making feedback redundant (Wulf et al. 2010). As such, an individual should have the opportunity to request feedback, which may occur commonly after good performances, leading to increased motivation and enhance the learning process (Chiviakowsky & Wulf, 2002; Chiviakowsky & Wulf, 2007). The benefits of allowing choice have been described in the OPTIMAL (Optimizing Performance through Intrinsic Motivation and Attention for Learning) theory of motor learning, where intrinsic motivation is increased through autonomy, thus leading to better learning (Wulf & Lewthwaite, 2016). However, conversations between coaches and players occur after both good and bad performances, thus labelling the success of these performances, especially in

dynamic team sports, is challenging (van Maarseveen et al., 2018). This is particularly relevant when considering video feedback from longer game or training sequences, which contain great quantities of information (Aiken et al., 2012).

Transfer from the PA process into competitive sport performance might only reflect improvements in general performance (e.g., number of passes made or shots on goal), which might be due to prioritising certain actions presented in the video feedback (Herold et al., 2022). Enabling responsibility over feedback, for example reviewing video in the athlete's own time, could be a positive practice (Vinson et al., 2017) to enhance motivation and perceived competence (Post et al., 2016). Furthermore, the retention and transfer of knowledge appears to be enhanced through self-controlled video feedback, suggesting that providing athletes with autonomy to control practice might benefit learning (Couvillion et al., 2020; Januário et al., 2019). However, it has recently been highlighted that there is a lack of robust evidence regarding feedback frequency in the motor learning literature, with the implication of such analyses suggesting that future research with studies comparing intervention groups of larger sample sizes are warranted in order to assess the effect or benefit and generalisability of self-controlled feedback methods (McKay et al., 2022b). Providing self-control over video feedback has been suggested to enhance the retention and transfer of knowledge (Couvillion et al., 2020; Januário et al., 2019), yet as highlighted, there is a lack of robust evidence regarding feedback frequency in the motor learning literature, and future research comparing intervention groups of larger sample sizes is warranted in order to assess the effect or benefit and generalisability of self-controlled feedback methods (McKay et al., 2022b).

Restructuring feedback sessions to enable co-creation of new knowledge and creative thinking is an important point to consider in the delivery of PA (Loo et al., 2020). An inclusive approach can support learning and autonomy, through athlete-initiated and collaborative processes, and ensuring the individual understands the importance of their contributions (Vinson et al., 2017). However, individual preferences of how feedback is provided should be considered, where coach knowledge of player understanding can be used to prescribe training measures designed for performance improvement (Brümmer, 2018). This reiterates the proposed learning benefits within OPTIMAL theory of providing autonomy or self-control to the learner (Lemos et al., 2018), where learning is influenced by enhancing expectancies coupled to the performers' goals with their movement patterns. Enabling coaches to reflect on their behaviours when conducting PA may provide

opportunities to consider the sequence in which they occur, which in turn may encourage greater autonomy in players (Raya-Castellano et al., 2021). Thus, an important consideration is the overall provision of PA as a learning process.

Conclusion

The aim of this integrative review was to examine the research that has considered the effect of video feedback during PA on learning in sport. Whilst still in its infancy in sports science research, conducting an integrative review enabled the critical analysis of both qualitative and quantitative research, broadening the body of research that met the inclusion criteria and aim of the review. Findings revealed a need for a change of focus in methodology, moving away from the prevalence of cross-sectional research to investigation through a greater variety of methods to truly examine the effect of video-based PA. This could also consider the application of video feedback in other settings, such as sport officials (Avugos et al., 2021), which may further enhance understanding of the factors impacting upon best-practice in the delivery of PA. Examination of different forms of feedback (e.g., self-controlled or peer to peer feedback in promoting self-regulated learning) which consider the environment in which PA is conducted and could also be considered. These areas in association with transfer tests or longitudinal intervention could then establish the effect of PA exposure, rather than the current reliance on perceived outcome in coach-dominated feedback processes. Finally, development of appropriate frameworks is required in order to aid knowledge and understanding of the delivery of PA, which in turn should enhance its impact and effect.

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Disclosure statement

The authors report there are no competing interests to declare.

Data availability statement

The literature search data is available through the Open Science Framework, which can be accessed via the following link: <https://osf.io/bqa6j>

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