Assessing the Efficacy of Video Telestration in Aiding Memory Recall Among Elite Professional Football Players

Jordan Smith, Steve Rands, Michael Bateman, and John Francis

Elite football (American soccer) clubs have invested heavily in the use of video telestration software in recent years; however, little is known regarding the benefits of this technology in aiding players' ability to recall events. Thus, the purpose of this study was to explore the effectiveness of video telestration in aiding memory recall of information among professional male football players. A randomized controlled trial was conducted, where an experimental group (n = 7) experienced telestration and a control group (n = 7) experienced no telestration over five sessions in 15 days. After watching either telestrated or non-telestrated clips, 24 hours later each individual completed a questionnaire comprised of questions regarding possession, chances creation, and set-pieces. The study revealed statistically significant differences (p < 0.001) in recall percentages for total recall, possession, chance creation, and set-pieces categories between the telestrated and non-telestrated groups. Set-pieces information was recalled the most when supplemented with video telestration and recalled the least in its absence (86.86% \pm 7.20% vs 48.00% \pm 9.24%). Subsequently, the results validate the investment in this technology, and it is suggested analysts and coaches should consider the use of telestration to support the wider performance analysis and coaching process to aid recall and facilitate player learning.

Keywords: feedback, learning, technology, soccer

Jordan Smith, MSc, is a first team training analyst with AFC Bournemouth. His applied research interests include examining performance analysis tools that aid learning and understanding.

Steve Rands, BSc, is head of performance analysis with Nottingham Forest Football Club. His research interests include examining performance analysis tools that aid learning and understanding.

Michael Bateman, MSc, is a lecturer in the School of Sport and Exercise Science at the University of Worcester, United Kingdom. His research interests focus on the importance of performance analysis within the coaching process. Email: m.bateman@worc.ac.uk

John Francis, PhD, is a senior lecturer in the School of Sport and Exercise Science at the University of Worcester, United Kingdom. His research explores how coaches, athletes, and support staff perceive the use of performance analysis to help improve the delivery of the sport science discipline. Email: j.francis@worc.ac.uk

Introduction

Performance analysis is a vital component of contemporary coaching processes, with the capability to provide accurate and effective feedback to athletes (Nelson & Groom, 2012). Advances in technology have coincided with positive benefits observed within the performance analysis industry, allowing sporting organizations to record and present information in creative ways to maximize their impact when being presented to athletes (Giblin et al., 2016). With previous research highlighting issues with memory recall among humans (Franks & Miller, 1986, 1991; Laird & Waters, 2008), emerging technologies have been advocated within feedback processes to enhance the recollection of performance-based information for coaches, analysts, and players (Pain & Harwood, 2007). Therefore, the utilization of technologies that help mitigate limitations in human observation have become widely accepted within the coaching community (Kraak et al., 2018; Wilson, 2008).

While previous research has investigated general perceptions of performance analysis among coaches, analysts, and players within elite sport (Francis & Jones, 2014; Wright et al., 2012), few have assessed the effectiveness of specific tools, products, and processes utilized within the applied performance analysis environment. This lack of research subsequently provides little justification in the expenditure spent by stakeholders on products that have no evidence of eliciting marked improvements in feedback mechanisms. One tool that is growing in popularity within football (American soccer) is video telestration, which allows users to interactively draw or annotate over still or moving images (Bogen et al., 2019). Initially popularized within sports broadcasting by market leaders such as PIERO (Ross Video, Ontario, Canada) and Coach Paint (Chyron, New York, USA), telestration software provides performance analysts with the capability to manipulate game footage to deliver meaningful tactical and technical information via visually stimulating graphics (Fischer et al., 2019). In doing so, video telestration provides augmented information to the viewing audience and has been theorized to enhance information retention (Budrionis et al., 2013, 2016; Ponsky et al., 2014).

Jones et al. (2020) conducted seminal research into the perceived value of telestration within elite football, surveying 58 professional coaches, players, and performance analysts operating in football clubs around the globe. Findings confirmed the widespread use of video telestration within footballing performance analysis provisions, with 93% of respondents describing video telestration as "essential – very important" to their practice. In particular, telestration was found to be of higher importance in opposition analysis, with 77% of analysts utilizing telestration "all the time" in their pre-match preparations. This reaffirms the utilization of telestration and could explain its rise in popularity within professional

football, especially when highlighting specific tactical nuances on upcoming opponents. One notable finding was that 51% of performance analysts use telestration tools to "aid retention" of information, despite there being no empirical evidence within football to substantiate this viewpoint. With only anecdotal evidence supporting these claims, this further emphasizes the importance of researching video telestration and assessing its effectiveness in aiding memory recall.

While little research has been published surrounding the efficacy of telestration tools within sport, there have been several studies published within the medical literature and have explored its use within surgical practices. In a randomized-control trial of eight telemedicine and eHealth students, Budrionis et al. (2016) reported that those who supplemented their training and mentoring with telestration completed tasks 33% faster, as well as having fewer miscommunications than those who did not utilize telestration. This reaffirms the view that a combination of telestration and verbal feedback can mitigate misinterpretations and, when paired with interactive elements, results in a higher standard of education (Laborde et al., 2017). Bogen et al. (2013) support this viewpoint, inferring that utilizing telestration enhances procedural and medical knowledge transfer; Feng et al. (2017) cite a correlation between knowledge gained and reduced effort to acquire that knowledge. As telestration tools have been shown to promote efficient and effective learning, this could potentially aid football clubs' performance analysis provisions, especially with aiding pre-match preparations. With professional football teams often competing every 2-3 days (Dellal et al., 2015), maximizing the impact of any contact time between the support staff and players could be vital in being able to deliver memorable tactical information, ensuring players are still briefed and fully prepared for upcoming fixtures.

Due to the previously mentioned advances in technology, modern-day athletes demand information differently from those they have superseded (Szymkowiak et al., 2021). Millennial and Generation Z athletes have been constantly exposed to technological stimulation throughout their lives and in doing so have altered neurocognitive function, resulting in shorter attention spans and enhanced multi-tasking capabilities (Gould et al., 2020; Parker et al., 2012). As a result of this, modern athletes prefer short, simplified, and visually engaging pieces of information (García-González et al., 2013; Raya-Castellano et al., 2020; Wadsworth et al., 2018). Consequently, telestration could become an essential tool for coaches in individualizing and evolving their practices to meet the educational demands of contemporary athletes (Erickson & Côté, 2016). In light of this, coupled with performance analysis already being a vital component of contemporary football coaching processes (Reeves & Roberts, 2013; Roberts et al., 2020), it would be prudent to investigate the practical efficacy of telestration and how it aids player learning within elite professional footballing environments.

Having reviewed previous literature surrounding medical telestration and its transferability to sporting feedback research, it could be postulated that telestration might enhance the retention of information from video feedback sessions. Supplementing these sessions with interactive elements positively impacts the educational quality and, in doing so, might help players recall tactical and technical information in a shorter period (Budrionis et al., 2016; Laborde et al., 2017). Consequently, players' on-field decision-making and tactical understanding should improve, individually producing more knowledgeable players and collectively enhancing team performance. With the established importance of performance analysis, seminal research into the use of video telestration in professional football and its possible benefits in developing players, this research seeks to explore the effectiveness of video telestration in aiding memory recall of information among professional male football players.

Materials and Methods

Participants

A total of 14 professional football players competing in the EFL Championship participated in this study. Participants were 25.3 ± 6.7 years of age with 7.2 ± 6.4 years of professional playing experience and covered a range of outfield positions (see Table 1). All participants had experienced video telestration as part of their club's performance analysis provision. All participants gave informed consent before participation in the study, which had gained ethical clearance from a university's Ethics and Governance Committee (SSES2021JS1), which satisfied the conditions of the Helsinki Declaration.

Procedure

A randomized controlled experimental trial was conducted to assess the efficacy of video telestration in aiding football players' recollection of information. Participants were randomly selected into an experimental group (n = 7) or a control group (n = 7). The randomization of participants was not repeated, as each group had a minimum of two participants with more than 10 years professional playing experience, ensuring an imbalance in groups due to the small sample size did not exist. The experimental group experienced telestration as part of this study, with the control group experiencing no telestration. Both groups completed five sessions over 15 days, with each session consisting of watching video clips relating to a single football team before receiving a questionnaire 24 hours later, followed by a rest period of 24 hours before the start of the next session. Each session was conducted every three days to mimic typical levels of

Table 1. Summary of Participant Demographic and Experimental Group

Group	Participant Number	Age (years)	Playing Position	Professional Playing Experience (years)
Telestrated	1	26	Forward	9
Telestrated	2	36	Midfielder	19
Telestrated	3	29	Defender	11
Telestrated	4	18	Defender	2
Telestrated	5	33	Goalkeeper	15
Telestrated	6	20	Midfielder	2
Telestrated	7	22	Forward	3
Non-Telestrated	8	21	Defender	3
Non-Telestrated	9	20	Forward	2
Non-Telestrated	10	38	Defender	16
Non-Telestrated	11	21	Defender	3
Non-Telestrated	12	19	Goalkeeper	1
Non-Telestrated	13	21	Midfielder	2
Non-Telestrated	14	30	Midfielder	13

fixture congestion observed in professional football (Dellal et al., 2015). The video clips were shared with participants via ShareFile (Citrix Systems, California, USA), where the link expired within 24 hours to ensure participants could not view the video while answering the corresponding questionnaire. To isolate and assess the effects of video telestration, all videos used as part of this study had no audio, as coach interaction has been evidenced to aid athlete recall of video information (Mason et al., 2021). All video clips received by the experimental group were telestrated using PIERO 16.1 (Ross Video, Ontario, Canada), with various annotations included to highlight relevant pieces of information to be included in the questionnaire. Video clips received by the control group were also exported via PIERO 16.1 but with all the telestration removed, ensuring participants received clips that were identical in length and video quality (see Figure 1). The video clips were approximately four minutes in duration, and the telestrated group received in the region on 25 telestrated points.

All participants received identical online questionnaires 24 hours after the sessions that were created and distributed online via SurveyMonkey (SVMK, California, USA). Similar to the video links, the questionnaires also had an expiration of 24 hours. The questionnaire was developed based upon validated tools





Figure 1:
Example of a telestrated video clip for the experimental group and a non-telestrated clip for the control group of the same game situation.

by Franks and Miller (1986) and Laird and Waters (2008), centered upon coaches' recollection of football-related information. The questionnaire was adapted to the objective of the present study but followed similar categories highlighted within previous research. As a result of this, three categories were developed (i.e., i. possession, ii. chance creation, and iii. set-pieces) with five questions in each category. The questionnaire comprised of closed multiple-choice and open short-answer questions. The use of closed questions allowed for direct comparison between respondents, while open questions ensured participants could provide additional context to their answers (Wright et al., 2013). The content of each questionnaire changed according to the team that was the focus of each video, ensuring no two questionnaires from each of the sessions were the same (see Appendix 1: Example questionnaire).

All questionnaires were completed by participants during May 2021. Before the start of the study, all participants received an information sheet explaining the purpose of the study and instructions on how to watch the video and complete the online questionnaire. Participants were able to save the progress of their responses during the 24-hour period to allow them to complete the questions in their own time.

Data Analysis

All 14 participants who engaged with the questionnaire in each of the five sessions fully completed it, meaning all 70 responses were selected for analysis. Open and closed questions were collated and coded as frequency counts for interpretation. All statistical analyses were conducted via R Studio (2022.07.01-Build 554). Initially, each participant's five completed questionnaires were combined; this involved analyzing an overall recall score out of 75 answered questions and three individual scores for the three question categories, which involved three separate scores per 25 questions. Means for the questionnaire scores and standard deviations were used to present the findings. A one-way ANOVA was conducted to compare differences in recall between the experimental and control groups (Nachar, 2008), following Levene's test of equality of error variance assuming equal variances. Following initial analysis, each participant's questionnaire score for each session were analyzed to explore whether recallability fluctuated over each session using a two-way ANOVA and the Tukey Honest Significant Differences Multiple Pairwise Comparisons. Means for the questionnaire scores and standard deviations were used to present the findings for each experimental condition over each session. The level of significance was set at $p \le 0.05$ for all analyses.

Results

Table 2 shows the overall recall rates of each participant from the experimental and control groups and how many questions they answered correctly of the 15 asked during each of the five sessions in the study. This indicates that the mean overall recall percentage for the experimental group, those that were exposed to telestrated clips, correctly recalled 84.00% ($SD \pm 3.69\%$) of the information while those within the control group, participants who received non-telestrated clips, correctly recalled 52.57% ($SD \pm 5.44\%$) of the information. There was a statistically significant difference between groups as determined by one-way ANOVA (F(1,12) = 160.147, p < .001).

Individual participant recall score and percentage are presented in Table 3 for each of the three question categories, with an indication as to whether the participant was in the experimental (telestrated) or control (non-telestrated) group. The mean possession category recall percentage for the experiment group ($84.00\% \pm 5.66\%$) was significantly higher than the control group ($56.00\% \pm 6.11\%$; F(1,12) = 79.154, p < .001). Within the chance creation category, a one-way ANOVA revealed there was a statistical difference between the experiment group (81.14%

Table 2. Total Number of Questions Answered Correctly by Each Subject for All Three Categories Over the Five Sessions

Group	Participant	Total Score	Total Recallability
Telestrated	1	61 / 75	81%
Telestrated	2	59 / 75	79%
Telestrated	3	65 / 75	87%
Telestrated	4	61 / 75	81%
Telestrated	5	64 / 75	85%
Telestrated	6	64 / 75	85%
Telestrated	7	67 / 75	89%
Non-Telestrated	8	46 / 75	61%
Non-Telestrated	9	36 / 75	48%
Non-Telestrated	10	44 / 75	59%
Non-Telestrated	11	36 / 75	48%
Non-Telestrated	12	37 / 75	49%
Non-Telestrated	13	40 / 75	53%
Non-Telestrated	14	37 / 75	49%

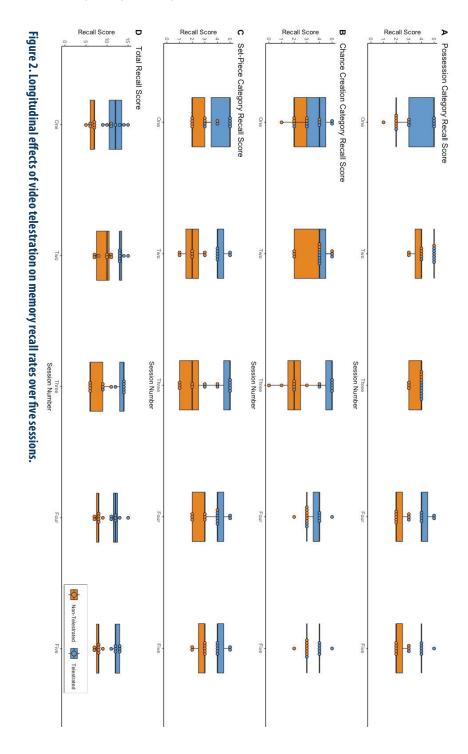
 \pm 6.41%) and the control (53.71% \pm 9.48%; F(1,12) = 65.524, p < .001). There was a significant difference in mean recallability for the set-pieces category (F(1,12) = 68.571, p < .001) between the experiment group (86.86% \pm 7.20%) and the control (48.00% \pm 9.24%). The data evidenced that telestration had a larger effect on improving set-piece recallability over the two other categories, and more individuals recalled less information within this category when they did not have access to telestrated clips.

Figure 2 highlights the longitudinal effects of telestration throughout the study in terms of the total number of questions answered correctly and breakdown by question category for each of the five sessions. There was no significant interaction between the obtained recall score in the experimental and control group, and session number for chance creation score (F(1,60) = 1.580, p = .191), set-pieces score (F(1,60) = 1.298, p = .281), and total recall score (F(1,60) = .350, p = .843). There was a significant interaction between the recall scores in the possession score between the two groups (F(1,60) = 3.699, p = .009) and the session number. Tukey Honest Significant Differences Multiple Pairwise Comparisons revealed significant comparisons between the second and fifth session

(p < 0.001), the second and forth session (p < 0.001), the third and first session (p = 0.032), and the second and first session (p < 0.001) in the possession score category. Regardless of the session number and the question category, all participants in the experimental group achieved higher recall scores. The first two sessions highlight a broader range of scores and closer recall rates across both groups. Within the third session, the recall scores in the possession category showed only small differences in recall accuracy, with all participants in the experiment group achieving a score of four out of five, while four out of seven participants achieved the same four out of five score when having no telestrated clips. However, in the third session, the recall scores showed greater differences in the chance creation and set-pieces category between the experiment and control group. In particular, a participant in the control group scored zero out of five in the chance creation category while four participants answered all five questions correctly. After sessions four and five, clearer differences in recall scores across all categories and both groups can be seen.

Table 3. Total Number of Questions Answered Correctly by Each Subject per Category Over the Five Sessions

Group	Participant	Possession Score	Possession Recallability	Chance Creation Score	Chance Creation Recallability	Set-Pieces Score	Set-Pieces Recallability
Telestrated	1	22 / 25	88%	19 / 25	76%	20 / 25	80%
Telestrated	2	19 / 25	76%	20 / 25	80%	20 / 25	80%
Telestrated	3	22 / 25	88%	22 / 25	88%	21 / 25	84%
Telestrated	4	20 / 25	80%	19 / 25	76%	22 / 25	88%
Telestrated	5	20 / 25	80%	19 / 25	76%	25 / 25	100%
Telestrated	6	23 / 25	92%	20 / 25	80%	21 / 25	84%
Telestrated	7	21 / 25	84%	23 / 25	92%	23 / 25	92%
Non-Telestrated	8	14 / 25	56%	16 / 25	64%	16 / 25	64%
Non-Telestrated	9	16 / 25	64%	11 / 25	44%	9/25	36%
Non-Telestrated	10	16 / 25	64%	17 / 25	68%	11 / 25	44%
Non-Telestrated	11	13 / 25	52%	12 / 25	48%	11 / 25	44%
Non-Telestrated	12	13 / 25	52%	13 / 25	52%	11 / 25	44%
Non-Telestrated	13	14 / 25	56%	14 / 25	56%	12 / 25	48%
Non-Telestrated	14	12 / 25	48%	11 / 25	44%	14 / 25	56%



SIJ

Discussion

The purpose of the present study was to assess the efficacy of video telestration in aiding the recallability of elite professional football players. The data revealed that video telestration significantly enhanced the memory recall of tactical information in possession, chance creation, and set-pieces, supporting the present study's hypothesis that telestration would aid the retention of information. In particular, participants in the telestrated group achieved overall recall rates of 84.00% ($SD \pm 3.69\%$). In comparison, participants in the non-telestrated group correctly recalled 52.57% (SD \pm 5.44%). Specifically, within the set-pieces categories, participants who had access to the telestrated clips achieved scores of either four or five out of five on 32 out of 35 observations in comparison to only three correct observations within the non-telestrated group. When considering the participants' recallability over the five sessions, the use of telestration aided recallability, with participants achieving higher scores in all categories in comparison to participants who did not have access to telestrated clips. Thus, our findings surrounding the use of video telestration and increasing recallability would help provide some objective evidence to highlight the benefits of this video-based tool and the potential positive influence on future performance analysis profession.

From an individual perspective, video telestration was beneficial in limiting variations in total levels of recall between players in the experimental group. As evidenced by Table 2, video telestration appears to mitigate inherent differences of recallability between players, with those who experienced telestration exhibiting less variation of recall than those who did not experience telestration. Similarly, in bridging gaps in expert knowledge between coaches and players, video telestration appears to have the same effect in bridging gaps in cognitive capabilities between players, eliciting improvements in learning quality (Laborde et al., 2017). Overcoming inherent differences in cognitive function is also mirrored in the barriers posed by differences in languages within playing squads. In the 2020-21 Premier League season, 63.7% of players were foreign nationals (Premier League, 2021), which highlights a common problem within contemporary footballing organizations. A mismatch of languages, paired with cultural player and coaching differences, may increase the likelihood of miscommunication during the performance analysis process. Preliminary findings within football have found that 49% of analysts utilize annotations to visually illustrate topics more clearly to minimize the risk of miscommunication during this performance analysis process (Jones et al., 2020). Enhancing the quality of video-based learning sessions with telestration tools suggests that key information may be better understood, overcoming inherent differences in player recallability and potential language differences, thus resulting in retaining more information.

Jones et al. (2020) highlighted that telestration allows educators to draw learners' attention to key events/moments. Laborde et al. (2017) supports these and reported that when live visual images are supplemented with interactive telestration, there is less misinterpretation among learners and a higher quality of education is attained. When examining the recallability of players and the effects of video telestration at the category level, the experimental group was able to recall more accurately than the control group (Set-pieces: $86.86\% \pm 7.20\%$ versus $48.00\% \pm 9.24\%$; Possession: $84.00\% \pm 5.66\%$ versus $56.00\% \pm 6.11\%$; Chance creation: $81.14\% \pm 6.41\%$ versus $53.71\% \pm 9.48\%$). In particular, the use of telestration for the set-pieces category highlighted a higher recallability than the possession and chance creation categories. This finding aligns with the work of Laird and Waters (2008), in which participants correctly recalled the most questions in the set-pieces category. This is not surprising, as set-pieces belong to static phases of play and are considered situations that are most receptive to choreographed routines and strategies compared to the unpredictable nature of open play (Carling et al., 2005; Suárez et al., 2014). Thus, set-pieces form a key focus of training and preparations ahead of upcoming opponents, requiring players to recall key roles and responsibilities such as the players they are marking or what routine to deploy during specific game-state scenarios (Stone et al., 2021). By recalling this information, players are expected to exhibit higher levels of performance during these situations via enhanced decision-making processes (Gorman et al., 2015; Helsen & Starkes, 1999). In light of this, video telestration can be seen as a beneficial tool in reinforcing key tactical match-winning information to players and directly affect their on-field performances. These findings are of particular importance when you consider the value of set-pieces, with more recent research indicating that they account for 31.5% of goals scored in the Top 6 European leagues (Prieto-Lage et al., 2021). However, it is important to note that both chance creation and possession-based questions also reported increased recallability when clips were telestrated rather than receiving non-telestrated clips, reinforcing the potential importance of this tool in aiding overall performance.

In terms of longitudinal use as part of a performance analysis provision, it is important to notice the spread of data points in the first two sessions. During these sessions, participants in both the telestrated group and non-telestrated group showed closer differences in achieved recall scores, albeit the telestrated group having a higher recall. The mechanisms behind this observation remain unclear, but it could be argued that due to the club utilizing telestration regularly, prior knowledge of the use of telestration and the players already being aware of the key points the club focuses on during preparation for games mitigated the differences between the control and experimental group. However, within the remaining three sessions, Figure 2 shows a clearer difference between recallability

across all three sessions, with the experimental group achieving higher recall scores, reinforcing the use of telestration to aid recallability. Vignon et al. (2018) support our findings in that due to the participants' pre-existing experience and use of telestration, once participants do not have access to previous learning materials and resources—in our case telestrated clips—they find it more challenging to recall events and help support learning and decision-making. Thus, since the repeated use of telestration had no negative effects on the enhanced levels of recall by players in the experimental group, video telestration can be suitably adopted for long-term use within performance analysis provisions and vindicates its widespread use within professional football.

Limitations

While results from the present study are insightful in revealing the extent to which video telestration aids memory recall of elite professional football players, there are limitations within its methodological approach that are worth noting. First, a larger sample of players would help increase our understanding of the use of telestration. However, the data yielded from the following research indicated statistical significance despite 14 players partaking in the study. Additionally, the average age of the players (25.3 ± 6.7 years) encompassed players from both Millennial and Generation Z backgrounds. Currently, Generation Z athletes account for 27% of the world population, with this number only increasing in the years ahead (Hampton & Keys, 2017). It would have been prudent to select a primarily Generation Z sample so that results could be generalizable to future footballing populations.

Another limitation was the footage utilized in the present study, providing players with videos comprised of footage from five Premier League teams during the 2020-21 season. Unlike previous authors, such as Laird and Waters (2008), no conscious effort was made to provide footage players may not have seen or forgotten about. This decision could potentially explain the surge of total correct answers observed in the second session, where more memorable footage may have led to increased levels of recall. In spite of this, due to the nature of promotion and relegation in many of football's league structures, many of the teams remain in the same division (Plumley et al., 2018), meaning teams and players are already familiar with one another. Thus, providing seemingly random footage would not be truly reflective of players' experiences with performance analysis processes and this was mirrored in the methodological approach adopted.

Another explanation for the results yielded in the second session could be the number of annotations provided as part of the telestration experienced by the experimental group. There was no limit to the amount of annotations provided to the experimental group as part of this study, and in doing so, there could be variations in the number of annotations provided to the players that may have influenced their ability to recall information. Based on previous research surrounding telestration, it could be hypothesized that an increased number of annotations minimizes the number of miscommunications, resultantly enhancing rates of recall due to a higher quality of education. However, this theme would need to be explored and is a potential avenue for future research surrounding the use of telestration in football

Future Research

Moving forward, it would be prudent to investigate the ideal number of annotations to include when telestrating footage, particularly when you consider the importance of player engagement as a performance analyst while also maintaining a high level of education. As well as this, assessing the effects of coach feedback when supplemented with video telestration would be an interesting avenue to explore. Furthermore, studying players within an academy setting, whereby they are developing their skills and tactical knowledge, could be a useful and beneficial addition to current processes. Lastly, the present study, both by design and circumstances due to COVID-19 regulations, omitted coaching figures to mitigate risks associated with the virus and to solely assess the effects of video telestration in isolation. Both research topics would have direct effects on the performance analysis process and its benefits would be observed by those working in the performance analysis profession the world over.

Conclusion

Using a sample of elite football players, this research sought to establish the extent to which video telestration aided the recall of key information. Results have established that telestration does aid retention of information, both for all assessed categories reported and also across the five sessions, justifying the monetary cost of such software packages within footballing organizations. It was also revealed that set-piece information was the primary benefactor of video telestration, which has implications on the utilization of telestration within football and the performance analysis profession. Based on the following research, video telestration holds considerable promise within the performance analysis and coaching process, enhancing the knowledge of players and providing potentially match-winning information that can be recollected on the field of play.

Acknowledgements

The researchers would like to thank the participants for their time engaging in the research process.

Conflict of Interest Statement

The authors state no conflict of interest.

Disclosure Statement

No author has any financial interest or received any financial benefit from this research

References

- Bogen, E. M., Aarsæther, E., Augestad, K. M., Lindsetmo, R. O., & Patel, H. R. H. (2013). Telemedical technologies in urological cancer care: Past, present and future applications. *Expert Review of Anticancer Therapy*, 13(7), 795–809. https://doi.org/10.1586/14737140.2013.811036
- Bogen, E. M., Schlachta, C., & Ponsky, T. (2019). White paper: technology for surgical telementoring-SAGES Project 6 Technology Working Group. Surgical Endoscopy, 33, 684–690. https://doi.org/10.1007/s00464-018-06631-8
- Budrionis, A., Augestad, K. M., Patel, H. R., & Bellika, J. G. (2013). An evaluation framework for defining the contributions of telestration in surgical telementoring. *Interactive Journal of Media Research*, 2(2), e14. https://doi.org/10.2196/IJMR.2611
- Budrionis, A., Hasvold, P., Hartvigsen, G., & Bellika, J. G. (2016). Assessing the impact of telestration on surgical telementoring: A randomized controlled trial. *Journal of Telemedicine and Telecare*, 22(1), 12–17. https://doi.org/10.1177/1357633X15585071
- Carling, C., Williams, A., & Reilly, T. (2005). *Handbook of soccer match analysis: A systematic approach to improving performance*. Routledge. https://doi.org/10.4324/9780203448625
- Dellal, A., Lago-Peñas, C., Rey, E., Chamari, K., & Orhant, E. (2015). The effects of a congested fixture period on physical performance, technical activity and injury rate during matches in a professional soccer team. *British Journal of Sports Medicine*, 49(6), 390–394. https://doi. org/10.1136/bjsports-2012-091290
- Erickson, K., & Côté, J. (2016). A season-long examination of the intervention tone of coach-athlete interactions and athlete development in youth sport. *Psychology of Sport and Exercise*, 22, 264–272.
- Feng, Y., Chhikara, J., Ramsey, J., & Mentis, H. M. (2017). Perceived usefulness and acceptance of telestration in laparoscopic training. AMIA Workshop on Interactive Systems in Healthcare (WISH 2017).
- Fischer, M. T., Keim, D. A., & Stein, M. (2019). Video-based analysis of soccer matches. *Proceedings of the 2nd International Workshop on Multimedia Content Analysis in Sports (MMSports '19)*, 1–9. https://doi.org/10.1145/3347318.3355515
- Francis, J., & Jones, G. (2014). Elite rugby union players perceptions towards performance analysis. *International Journal of Performance Analysis in Sport, 14*(1), 188–207. https://doi.org/10.1080/24748668.2014.11868714
- Franks, I., & Miller, G. (1986). Eyewitness testimony in sport. *Journal of Sport Behavior*, 9(1), 38–45.
- Franks, I., & Miller, G. (1991). Training coaches to observe and remember. *Journal of Sports Sciences*, 9(3), 285–297. https://doi.org/10.1080/02640419108729890
- García-González, L., Moreno, P., Moreno, A., Gil, A., & del Villar, F. (2013). Effectiveness of a video-feedback and questioning programme to develop cognitive expertise in sport. *PLoS ONE*, 8(12), e82270.

- Giblin, G., Tor, E., & Parrington, L. (2016). The impact of technology on elite sports performance. Sensoria: A Journal of Mind, Brain and Culture, 12(2). https://doi.org/10.7790/sa.v12i2.436
- Gorman, A. D., Abernethy, B., & Farrow, D. (2015). Evidence of different underlying processes in pattern recall and decision-making. *The Quarterly Journal of Experimental Psychology, 68*(9), 1813–1831. https://doi.org/10.1080/17470218.2014.992797
- Gould, D., Nalepa, J., & Mignano, M. (2020). Coaching Generation Z athletes. *Journal of Applied Sport Psychology*, 32(1), 104–120. https://doi.org/10.1080/10413200.2019.1581856
- Hampton, D. C., & Keys, Y. (2017). Generation Z students: Will they change our nursing classrooms? *Journal of Nursing Education and Practice*, 7(4), 111–115. https://doi.org/10.1097/00006223-900000000-99539
- Helsen, W. F., & Starkes, J. L. (1999). A multidimensional approach to skilled perception and performance in sport. *Applied Cognitive Psychology*, 13(1), 1–27. https://bit.ly/3UzbJ8x
- Jones, D., Rands, S., & Butterworth, A. D. (2020). The use and perceived value of telestration tools in elite football. *International Journal of Performance Analysis in Sport*, 20(3), 373–388. https://doi.org/10.1080/24748668.2020.1753965
- Kraak, W., Magwa, Z., & Terblanche, E. (2018). Analysis of South African semi-elite rugby head coaches' engagement with performance analysis. *International Journal of Performance Analysis in Sport*, 18(2), 350–366. https://doi.org/10.1080/24748668.2018.1477026
- Laborde, C. J., Bell, C. S., Slaughter, J. C., Valdastri, P., & Obstein K. L. (2017). Evaluation of a novel tablet application for improvement in colonoscopy training and mentoring (with video). *Gastrointestinal Endoscopy*, 85(3), 559–565. https://doi.org/10.1016/j.gie.2016.07.052
- Laird, P., & Waters, L. (2008). Eyewitness recollection of sport coaches. *International Journal of Performance Analysis in Sport*, 8(1), 76–84. https://doi.org/10.1080/24748668.2008.11868424
- Mason, R. J., Farrow, D., & Hattie, J. A. (2021). An exploratory investigation into the reception of verbal and video feedback provided to players in an Australian Football League club. *International Journal of Sports Science and Coaching*, 16(1), 181-191. https://doi.org/10.1177/1747954120951080
- Nachar, N. (2008). The Mann-Whitney U: A test for assessing whether two independent samples come from the same distribution. *Tutorials in Quantitative Methods for Psychology*, 4(1), 13–20.
- Nelson, L., & Groom, R. (2012). The analysis of athletic performance: Some practical and philosophical considerations. Sport, Education and Society, 17(5), 687–701. https://doi.org/10.1080/13573322.2011.552574
- Pain, M., & Harwood, C. (2007). The performance environment of the England youth soccer teams. Journal of Sports Sciences, 25(12), 1307–1324. https://doi.org/10.1080/02640410601059622
- Parker, K., Czech, D., Burdette, T., Stewart, J., Biber, D., Easton, L., Pecinovsky, C., Carson, S., & Mcdaniel, T. (2012). The preferred coaching styles of Generation Z athletes: A qualitative study. *Journal of Coaching Education*, 5(2), 5–23. https://doi.org/10.1123/jce.5.2.5
- Plumley, D., Ramchandani, G., & Wilson, R. (2018). Mind the gap: An analysis of competitive balance in the English Football League system. *International Journal of Sport Management* and Marketing, 18(5), 357–375. https://doi.org/10.1504/IJSMM.2018.094344
- Ponsky, T. A., Schwachter, M., Parry, J., Rothenberg, S., & Augestad, K. M. (2014). Telementoring: The surgical tool of the future. *European Journal of Pediatric Surgery*, 24(4), 287–294. https://doi.org/10.1055/S-0034-1386646/ID/JR143037REV-33
- Premier League. (2021). Players. http://www.premierleague.com/players?se=418&cl=-1

- Prieto-Lage, I., Bermúdez-Fernández, D., Paramés-González, A., & Gutiérrez-Santiago, A. (2021). Analysis of the corner kick in football in the main European leagues during the 2017-2018 season. *International Journal of Performance Analysis in Sport, 21*(4), 611–629. https://doi.org/10.1080/24748668.2021.1932146
- Raya-Castellano, P., Reeves, M. J., Littlewood, M., & McRobert, A. P. (2020). An exploratory investigation of junior-elite football coaches' behaviours during video-based feedback sessions. International Journal of Performance Analysis in Sport, 20(4), 729–746. https://doi.org/10.1080/24748668.2020.1782717
- Reeves, M., & Roberts, S. (2013). Perceptions of performance analysis in elite youth football. International Journal of Performance Analysis in Sport, 13(1), 200–211. https://doi.org/10.1080/24748668.2013.11868642
- Roberts, S. J., Rudd, J. R., & Reeves, M. J. (2020). Efficacy of using non-linear pedagogy to support attacking players' individual learning objectives in elite-youth football: A randomised cross-over trial. *Journal of Sports Sciences*, 38(11–12), 1454–1464. https://doi.org/10.1080/0264 0414.2019.1609894
- Stone, J. A., Smith, A., & Barry, A. (2021). The undervalued set piece: Analysis of soccer throwins during the English. *International Journal of Sports Science and Coaching*, 16(3), 830–839. https://doi.org/10.1177/1747954121991447
- Suárez, T. A., Dios, R. M., Boubeta, A. R., López, J. L. L., & Sanjurjo, C. A. C. (2014). Efficiency analysis of corner kicks in the 2010 World Cup. Trying to identify the explanatory variables. Revista de Psicologia Del Deporte, 23(1), 165–172. https://archives.rpd-online.com/article/view/v23-n1-arda-maneiro-rial-etal.html
- Szymkowiak, A., Melović, B., Dabić, M., Jeganathan, K., & Kundi, G. S. (2021). Information technology and Gen Z: The role of teachers, the internet, and technology in the education of young people. *Technology in Society*, 65. https://doi.org/10.1016/j.techsoc.2021.101565
- Vignon, P., Pegot, B., Dalmay, F., Jean-Michel, V., Bocher, S., L'her, E., Cros, J., Prat, G., Baudrier, F., Charpentier, M., Chatenet, E., Danthu, C., Dargere, M., Depays, F., Dubos, M., Durand, B., Gauthier, F., Geslain, M., Guilbault, P., ... van Nho, J. T. (2018). Acceleration of the learning curve for mastering basic critical care echocardiography using computerized simulation. *Intensive Care Medicine*, 44(7), 1097–1105. https://doi.org/10.1007/S00134-018-5248-Z
- Wadsworth, N., Charnock, L., Russell, J., & Littlewood, M. (2018). *Use of video-analysis feedback within a six-month coach education program at a professional football club*. https://doi.org/10.1 080/21520704.2018.1528324
- Wilson, B. D. (2008). Development in video technology for coaching. *Sports Technology, 1*(1), 34–40
- Wright, C., Atkins, S., & Jones, B. (2012). An analysis of elite coaches' engagement with performance analysis services (match, notational analysis and technique analysis). *International Journal of Performance Analysis in Sport, 12*(2), 436–451. https://doi.org/10.1080/24748668.20 12.11868609
- Wright, C., Atkins, S., Jones, B., & Todd, J. (2013). The role of performance analysts within the coaching process: Performance analysts survey 'The role of performance analysts in elite football club settings.' *International Journal of Performance Analysis in Sport, 13*(2), 240–261. https://doi.org/10.1080/24748668.2013.11868645

Appendix 1. Example Questionnaire

ionnaire - Session 2 01/02/2022, 09:42
Group 1 Questionnaire - Session 2
Question 1 - Whilst building the attack, which line will Aston Villa most often? Mark only one oval. 1st Line 2nd Line 3rd Line
Question 2 - What formation do Aston Villa play? Mark only one oval. 4-4-2 4-3-3 3-5-2 3-4-3
Question 3 - If the top of the wide diamond comes short, what does the striker do?
Question 4 - When pressed at goal kicks, which Aston Villa player was as a 3rd line option f the goalkeeper? Description 4 - When pressed at goal kicks, which Aston Villa player was as a 3rd line option f the goalkeeper? Description 4 - When pressed at goal kicks, which Aston Villa player was as a 3rd line option f the goalkeeper?

Group 1 Questionnaire - Session 2 01/02/2022, 09:42				
5.	Question 5 - Do Aston Villa press from the front?			
	Mark only one oval.			
	Yes			
	No			
6.	Question 6 - Whilst in possession, the central midfielder will look for which movement by tl striker?			
7.	Question 7 - What does the corner run allow the winger to do?			
	Mark only one oval.			
	Make an overlap			
	Hold their width			
	Make an out / in run			
	Occupy the corridor			
8.	Question 8 - When attacking crosses, movement towards the goal allows which pass to be on?			
https://docs.go	ogle.com/forms/u/1/d/19jRqlKwSC7Cif3XrQWyhf6DOAovLyCKsus8FNRl1c9o/printform Page 2 of 5			

Group 1 Quest	ionnaire - Session 2 01/02	2/2022, 09:42				
9.	Question 9 - Ollie Watkins will usually make runs to which area in the box?					
	Mark only one oval.					
	Far post					
	Penalty spot					
	Near post					
	6-yard box					
10.	Question 10 - For Aston Villa's 3rd goal vs Fulham, which movement pattern can be observed in the build-up?	oe				
11.	Question 11 - Which zone do Aston Villa attack on corners?					
	Mark only one oval.					
	Near post					
	6-yard box					
	Far post					
	Penalty spot					
12.	Question 12 - How do Aston Villa sustain attacks from unsuccessful corners?					
13.	Question 13 - Which player was Aston Villa's short option for corners?					
https://docs.g	oogle.com/forms/u/1/d/19]RqlKwSC7Cif3XrQWyhf6DOAovLyCKsus8FNRI1c9o/printform	Page 3 of 5				

Group 1 Questionnaire - Session 2			
14. Question 14 - What is Aston Villa's strategy for defending corners? Mark only one oval.			
Man Marking			
Zonal			
Man Marking & Zonal			
15. Question 15 - On which post is there an Aston Villa player?			
Mark only one oval.			
Near post			
Far post			
No players are on the posts			